Ottawa Water Supply from the Gatineau Lakes.

Ottawa, October 9th, 1913.

To the Members of the City Council,
Ottawa.

Gentlemen,—

In February last Sir Alexander R. Binnie and Dr. A. C. Houston reported that in their opinion the Ottawa River water in its raw state was unfit for domestic use. Also that the water can only be made satisfactory by the use of chemicals. They recommended abandoning the Ottawa River as a source of supply and going to the Gatineau Lakes. They stated that they could not designate the exact lake or lakes which should be selected without further extended enquiries and surveys. Since then these enquiries and surveys have been made. Under ordinary conditions it would have taken about two years to make the necessary surveys, owing to the fact that no reliable survey had ever been made of the Gatineau lake district, and very little data was available. The Dominion Geodetic Survey, however, put a large staff upon the work, with the result that Messrs. Binnie and Houston are now enabled to make their final report.

I forward herewith the following reports, communications, and documents:—

(1) Report of Sir Alexander R. Binnie upon Pemachangaw and Thirty-one Mile Lakes; also upon the McGregor Lake area.

(2) Report of Dr. A. C. Houston upon the same lakes.

(3) Estimate of F. A. Gendron, M.P.P., of value of lands, lakes, right of way, compensation, etc.

(4) Copy letter from myself to Rt. Hon. R. L. Borden, memo referred to in that letter, and letter from the Premier to myself.

(5) Report of City Auditor Cluff as to present annual cost of pumping, etc.

(6) Report of City Engineer and City Auditor as to cost of probable additions required to present pumping plant.

(7) Letter from Fire Underwriters' Association dated 24th September, 1913.

(8) Report of City Engineer Currie and W. S. Lea, of Montreal, as to the pressure in city which the Gatineau Lakes gravity supply will give.

(9) Report of City Engineer Currie on Lake Deschenes overland pipe, without filtration.

(10) Letter from Provincial Board of Health dated 7th April, 1913.

(11) Letter from City Treasurer as to interest and sinikng fund charges.

(12) Cables between myself and Ozone Company of Paris.

(13) Extract from Report of Messrs. Hering & Fuller of New York to City of Montreal, dated 2nd July, 1910, as to ozone treatment.

All the reports, data, and information herewith presented have been prepared on the basis of a water supply of 25 million gallons per day, and the estimates for every scheme are based upon the delivery of that quantity of water. Sir Alexander Binnie and Mr. Allan Hazen agree that this amount of water is sufficient for a population of 250,000 persons. If the reports and estimates had been prepared upon the delivery of a greater supply of water than 25 million gallons per day the comparison of cost would have been more in favor of the Gatineau Lakes than it is.

TD 227
O7
O77

Lakes Pemichangaw and Thirty-One Mile.

The Reports of Messrs. Binnie and Houston recommend the adoption of these lakes and their watershed as the source of supply.

Sir Alexander Binnie states that the water is of "exceptional quality." Also that there will never "be the slightest necessity to filter this water, and should Ottawa adopt these lakes as a source of supply *one of the finest water supplies in the world would be secured.*"

"It is as far as I know *the purest source of supply in the world*, and practically free from any future contamination. This cannot be said of either the McGregor Lake supply or one derived from the Ottawa River, both of which would require filtration and the use of chemicals to make them safe and potable."

"If the Thirty-One mile Lake project is adopted, the City of Ottawa will have a supply for a very distant period in the future, which cannot be said of McGregor Lakes."

Dr. Houston says: "I have read and agree with the recommendations of Sir Alexander R. Binnie."

"I recommend the Thirty-one Mile Lake scheme in preference to the McGregor Lakes, because the former water is better on topographical, epidermiological, bacteriological, chemical, physical and algae grounds.

"The Thirty-One Mile Lake source of supply is *unimpeachable on public health grounds*, and *the water is of excellent quality, physically and chemically.*

"The Thirty-One Mile Lake water would ensure to Ottawa *immunity from water-borne epidemic diseases, for example, typhoid fever. This water is tasteless, odorless, and practically free from turbidity. It is almost colorless, and very soft.*

"The Thirty-One Mile Lake water being physically satisfactory and free from human pollution, requires no filtration or other purification process.

"I am totally opposed to the Ottawa River as a source of supply."

The total area of the watershed of Lakes Pemichangaw and Thirty-one Mile, including a large number of smaller lakes in the watershed, is about 150 square miles. It is proposed to remove from the lakes and watershed all permanent residents and to create it a reserve. Provision has been made for this in the estimates.

These lakes and watershed will furnish a supply of 81 million gallons per day, or sufficient for 750,000 people.

It is proposed to bring the water from the lakes by a pipe line about 50 miles in length. Near Chelsea there will be a service reservoir which will hold about 12 days' supply. There will be one pipe from the lakes to the reservoir which will be 54 inches in diameter. This pipe will bring down 25 million gallons per day. From the reservoir to Ottawa there will be two pipes, each 51 inches in diameter. These pipes will carry 46½ million gallons per day. The pipes proposed will supply water for a population of 250,000. When the population is more than that further water can be taken from the lakes until a population of 750,000 is reached.

There will be no pipes under water. The crossings of the Gatineau and Ottawa Rivers are to be made overhead by suspension bridges. The Ottawa River will be crossed close to the present Union suspension bridge at the Chaudiere.

The estimated cost of the whole proposition, including the acquisition of the lakes, lands, the watershed of 150 square miles, right of way, etc., is $7,985,200, say, $8,000,000.

I have in my possesion detail sheets of the various items in the estimate. The estimates of cost for steel pipes, etc. have been arrived at by getting actual quotations from leading manufacturers. For excavation and construction work the estimates are based upon the local prices paid for labour and materials. These prices have been determined after consultation with City Engineer Currie, and are concurred in by him. The estimate of the cost of the lakes, lands, right of way, etc., has been made by Mr. F. A. Gendron, M.P.P.

Under the Special Act obtained at the last session of the Ontario Legislature fifty year debentures can be issued for the scheme. The annual interest and sinking fund on $8,000,000 is $412,400, as per the letter of the City Treasurer attached. To this is to be added $15,000 per annum for maintenance, making a total annual expenditure of $427,400.

The attached letter of the Rt. Hon. R. L. Borden states that *the Dominion Government is prepared to pay* $100,000 *per annum direct to the city* as a contribution to the new water supply. This includes the $15,000 a year now paid by the Government to the city, and is therefore an additional yearly grant of $85,000. This additional payment is equivalent to a cash contribution of about one and three quarter million dollars. The letter states that the source of the proposed water supply must be "Recommended and approved by competent experts whose opinion commends itself to the Government."

There is no doubt but that the Government considers Messrs. Binnie and Houston to be "competent experts," and that therefore the new grant of $85,000 a year will be made to the water supply for Lakes Pemichangaw and Thirty-One Mile recommended by them. I also think it can be stated that the grant will not be made for any other proposal.

The letter from the Premier also says that "The present arrangements under which an annual grant is made for the purposes of the Ottawa Improvement Commission will be unaffected by the proposals which are above outlined." I think that what the Government proposes to do should be eminently satisfactory to the people of Ottawa.

The attached report of the City Auditor states that the present annual cost of pumping and treating water from the Ottawa River, etc., is $68,684. The report also attached of the City Auditor and the City Engineer shows that in order to bring the present pumping plant up to a capacity of 25 million gallons per day a further annual expenditure of $11,140 will be necessary. This added to the above $68,684 makes a total annual expenditure of $79,824, say $80,000, which the city will be saved if a gravity supply of water, such as is proposed, is adopted.

The extra annual charge which the city will therefore have to meet if Messrs. Binnie and Houston's recommendation is adopted is as follows:—

Annual interest and sinking fund on $8,000,000		412,400
Annual maintenance of proposed gravity supply		15,000
Total		$427,400
Less		
New annual contribution by Dominion Government	$85,000	
Annual cost of pumping, etc., saved	80,000	165,000
Total annual extra charge to city		$262,400

I have no hesitation whatever in saying that, with careful management of the city's finances, *this annual charge can be met without any increase whatever in the present tax rate or water rates.*

Last year there was a deficit of nearly $160,000 in the city's g[illegible] count. This deficit has been paid out of this year's revenue witho[illegible] ing any of the civic services, and my expectation is that after pay[illegible] $160,000 the city's general account for 1913 will show only a very [illegible]ll deficit, if any at all. In other words next year and every year thereafter, the city will have about $160,000 of revenue available after making all proper allowances for all civic services. In my opinion this $160,000 per annum can be applied in no better way than towards paying for a pure water supply.

On account of the large deficit in the waterworks account last year it was necessary to increase the water rates this year 20 per cent. It was intended that this increase in the water rates should only be for 1913 and 1914, as it was expected that this would wipe out the water works deficit of last year. The increase of 20 per cent. in water rates equals about $60,000 per annum. If the water rates are left as they are there will thus be $60,000 available for the Gatineau water supply from this source after 1914. With the $60,000 per annum and the above $160,000 per annum available from the city's general fund, as above mentioned, I see no reason, as I have before stated, why the project recommended by Messrs. Binnie and Houston cannot be financed without increasing either the present tax rate or the water rates.

The Acquisition of the Lakes, Land, Right of Way, etc.

In May last I, along with Senator Belcourt and others, interviewed the Premier of the Province of Quebec, Sir Lomer Gouin, to ascertain if the city could acquire the necessary lakes and unpatented lands from the Government of the Province of Quebec. From the assurances we received I am satisfied that the city will be able to do this on reasonable terms.

The projected pipe line runs parallel with the Gatineau Valley Railway for about 24 miles. From interviews which I have had with C.P.R. officials I think they will allow the city to use so much of their right of way as is required for the pipe line.

Under the Special Act secured by the city from the Dominion Parliament at its last session, the city can acquire, by expropriation if necessary, whatever lands and right of way are required for the pipe line, reservoir, etc.

Under the same Act the city can, by agreement with the City of Hull, construct its pipe line through that city, subject to an agreement to be entered into with that city, the terms of which are to be settled by the Public Utilities Commission of the Province of Quebec in the event of the two cities being unable to agree.

The Act of the Dominion Parliament referred to removes any doubts there might have been as to the right of the City of Ottawa to acquire and hold in that Province any lakes and land required for a water supply, reservoir, and pipe line, and to operate and maintain the same.

The Special Act also obtained at the last session of the Ontario Legislature gives the necessary authority to the city to expend money for the purposes mentioned in the Province of Quebec.

Fire Protection and Insurance Rates.

Both Gatineau Lake supplies reported upon by Messrs. Binnie and Houston are perfect gravity supplies, and will give the greatest pressure possible in all parts of the city. City Engineer Currie and Mr. W. S. Lea, of Montreal, who is now enquiring into the city's water distribution system, have made a report to me as what pressure the proposed Gatineau Lake supply will give in the city, which report is hereto attached. They state that when 25 to 30 hydrants are going on Wellington, Sparks and Queen streets, which is practically all there are in that vicinity, there will still be a pressure at the corner of Metcalfe and Sparks street of 80 pounds. This is about the highest point in the city. The pressure in the lower parts will, of course, be still greater.

The service reservoir is at an elevation of about 190 feet higher than Sparks street.

With this pressure it will not be necessary for the city to maintain as many fire engines as at present. One or two will be required in the vicinity of Sparks street on account of the very high buildings there, but in the other parts of the city none will be required. With the gravity supply proposed every hydrant will practically be a fire engine.

A gravity supply of water is the ideal form of fire protection. The letter of the Fire Underwriters' Association attached states that, "*A general reduction in insurance rates would be made in your city* as soon as such a scheme for water supply as outlined is carried out." Also that the scheme proposed "would for fire purposes be the best obtainable, and the Underwriters would be very glad to see your city so equipped, and to give you the fullest possible recognition in the way of improved rates."

In considering the cost of the project recommended by Messrs. Binnie and Houston, it must therefore be borne in mind that when it is installed there will be a general reduction in fire insurance rates, and the city's expenditure in connection with its fire brigade would also be reduced.

McGregor Lake Watershed.

Dr. Houston recommends the Thirty-One Mile Lake scheme in preference to the McGregor Lakes. His reasons therefor have already been given.

He also states that "Filtration of the McGregor Lakes may not be absolutely necessary, but in view of possible algae trouble and undesirable pollution advise the inclusion of the cost of filtration in the estimates."

Sir Alexander Binnie states that the water of Thirty-One Mile and Pemichangaw Lakes is unquestionably "superior in quality to the McGregor Lake water." Also that mechanical filtration of the latter water would be necessary. He also says that the farms and residences surrounding the McGregor Lakes should be purchased "as there are far too many possibilities of infection of the water taking place, in fact the population in the drainage area is considerably higher than that on the basin of the Ottawa River."

Mr. Hazen recommended that one pipe only be laid from McGregor Lake to Ottawa, crossing the Ottawa River under water with two pipes at Kettle Island. This made a pipe line of about 16 miles. No service reservoir was provided for in his scheme. Sir Alexander Binnie, for the reasons he gives, is of opinion that a service reservoir is of vital importance to a gravity supply of water. He says that when none is provided "it would be necessary to lay two pipes all the way from the source of supply in order to be able to shut off one line while the supply is kept up by the other."

Sir Alexander Binnie advises that if the McGregor Lake scheme is adopted there should be a service reservoir at Chelsea, as provided for in the Thirty-One Mile and Pemichangaw Lakes project. Then one pipe line could be run from McGregor Lake to that reservoir, and two pipes from the reservoir to the city. This would make a pipe line of about 21 miles.

The total area of the watershed of the McGregor Lakes is about 94 miles. These lakes and watersheds will furnish a supply of 51 million gallons per day.

The estimated cost of the McGregor Lake project, according to the report of Sir Alexander Binnie, is $7,054,313, say $7,000,000. This includes $2,000,000 for land, lakes, compensation, right of way, etc., which is the estimate given by Mr. F. A. Gandron, M.P.P. The latter explains that this valuation is so much greater than that for Thirty-One Mile Lake and Pemichangaw because "in the McGregor Lake watershed nearly all the land is patented and a large proportion of it is cleared. This is not the case with regard to Thirty-One Mile and Pemichangaw watershed." I understand that whilst there are only about 25 homesteads in the Thirty-One Mile Lake and Pemichangaw area that there are over 250 in the McGregor Lake.

The cost of the McGregor Lake proposition is also increased by $500,000 having to be added for a filtering plant.

Under the Special Act of the Ontario Legislature, fifty year debentures can also be issued for the McGregor Lake scheme. The annual interest and sinking fund on $7,000,000 is $360,850 ,as per letter of the City Treasurer attached. To this is to be added $29,000 per annum for maintenance and working expenses, making a total annual expenditure of $389,850. The increased annual charge for maintenance over that of Thirty-One Mile Lake ad Pemichangaw is occasioned by the inclusion of the cost of operating the filtration plant.

If the McGregor Lake scheme is adopted in the form given by Sir Alexander Binnie it will give the same gravity supply as Thirty-One Mile Lake and Pemichangaw. There will therefore have to be deducted from the above $389,650, the same amount for annual expenditure saved for pumping, etc., as in the Thirty-One Mile Lake and Pemichangaw project, namely, $80 000.

The extra annual charge which the city will therefore have to meet if the McGregor Lake proposition is adopted is $309,850.

Lake Deschenes, Overland Pipe. Without Filtration.

Some time ago I asked City Engineer Currie to report to me upon the following proposition:—

"If the City of Ottawa continues to use the Ottawa River water in its "natural condition as a permanent source of supply what would be the best "point from which the water should be taken, and what works would re-"quire to be constructed, with an estimate of the expense of such works."

His report states that in his opinion the most suitable point from which to take the water is a little west of Ennis' Point in Lake Deschenes and opposite Aylmer Island. This is over 14 miles from the pumping station. Mr. Currie finds that the gradients are such that the water could not be carried by gravity to the pumping plant, and that therefore another pumping plant would require to be installed and operated at Lake Deschenes. As no hydraulic power can be secured there this plant must be operated by electric power.

The City Engineer proposes that a small low level service reservoir to hold 10 million gallons be constructed just inside the city limits at Hintonburgh, to provide a reserve of water in case of fire, and to enable the water to flow by gravity from the reservoir to the present pumping station. He also proposes to have two 48 inch pipes from the intake at Lake Deschenes to the service reservoir, and two 4[illegible] inch pipes from the reservoir to the pumping station.

The estimated cost of this project is $2,881,819, say $2,900,000. Inasmuch as there is no special legislation for the sceheme, and I am quite sure none can be obtained, the debentures would have to be issued for the ordinary term of 30 years. The annual interest and sinking fund on $2,900,000 is $191,450, as per letter of the City Treasurer attached. To this is to be added $20,000 yearly maintenance and operating expenses of the pumping plant at Lake Deschenes, including electric power, etc., making a total annual expenditure of $211,450.

Provincial Board of Health.

This Board has authority to say what waterworks system shall be used by any municipality, and from what source the supply of water shall be taken. The attached letter from the Board states that that body will not allow the City of Ottawa to use the water of the Ottawa River or of Lake Deschenes without filtration.

The report and estimates of City Engineer Currie, above mentioned, do not include the cost of filtration.

Mechanical Filtration of Ottawa River at Lemieux Island.

(As recommended by Mr. Allen Hazen.)

Mr. Allen Hazen reported upon this proposition in 1910 and 1912. His estimate of the cost of a mechanical filtration plant to supply an average daily consumption of 2[illegible] million gallons per day was $1,100,000. (See page 875, Minutes of Council, 1912). Mr. Hazen's estimate of the cost of filtrating the water was $6.26 per million gallons, or $41,000 per annum for [illegible] 000,000 gallons per day. (See his Report, page 4, printed in Minutes of Council, 1910). Applying these figures for cost of filtering to the quantity of water to be supplied by the Gatineau Lakes project, namely, 25 million gallons per day, gives an annual yearly cost for filtering of $57,000.

The letter of the City Treasurer attached shows that the annual charges which the city would have to pay for interest and sinking fund on the $1,100,000 required to construct the filtration plant are $72,500.

The annual cost to the city of mechanical filtration, according to Mr. Hazen's estimates, would therefore be:—

Interest and Sinking Fund	$ 72,600
Maintenance and filtering	57,000
Total	$129,600

Mechanical filtration will of course in no way give any improved fire protection.

Madawaska River.

Respecting this source of supply I think it only necessary to quote the following from the report of Sir Alexander Binnie to the City Council, dated 15th February last:—

"The country drained by the Mississippi River, White Lake, and Madawaska River, is not to be compared to the lake district north of the Ottawa River. Calabogie Lake, I fear would be too distant, and its altitude too low for economical construction, as it would involve a very large pipe to convey the water."

Ozone Treatment of Ottawa River.

The cables between myself and Compagnie Generale de l'Ozone of Paris attached hereto, show that this company proposed to supply 25 million gallons of water per day treated with Ozone to the city. I asked what they would charge for this, but so far I have not received any price.

Ozone treatment is first filtration of the water, and then, when all the impurities have been removed, treatment with electric current.

In view of the report made by Messrs. Hering and Fuller of New York to the city of Montreal upon this subject, a copy of which is also attached hereto, I do not think it necessary to say anything further about this matter.

Summary of Annual Cost to City.

1.	Lake Pemichangaw and Thirty-One Mile area	$262,400
2.	McGregor Lake area	309,850
3.	Lake Deschenes overland pipe, without filtration	211,450
4.	Mechanical filtration of Ottawa River at Lemieux Island	129,600
5.	Ozone treatment of Ottawa River	not known.

I have not the slightest hesitation in advising that the recommendation of Messrs. Binnie and Houston be adopted.

I also strongly recommend that the City Council pass the money by-law authorized under the special legislation obtained at the last session of the Ontario Legislature.

The report of Sir Alexander Binnie states that the work can be completed so that the water could be brought to the city in three years, that is early in 1917. To do this however it is absolutely necessary that everything be rushed on as rapidly as possible. The report adds:—"Any delay would mean that water could not be brought in from this source before 1918."

In order that the work may be gone on with at once, so that it can be completed in three years, I therefore also recommend that the Council deal with the matter and dispose of it at the earliest possible date.

J. A. ELLIS,
Mayor.

Since writing the above I have received a definite price from the Ozone Company of Paris. They offer to treat with Ozone 25,000 gallons per day of Ottawa River Water at a cost to the city of $266,000 per year.

l Mad-
the Ot-
ltitude
ge pipe

Paris
n gal-
t they

ll the

York
ached
atter.

2,400
),850
,450
),600
own.

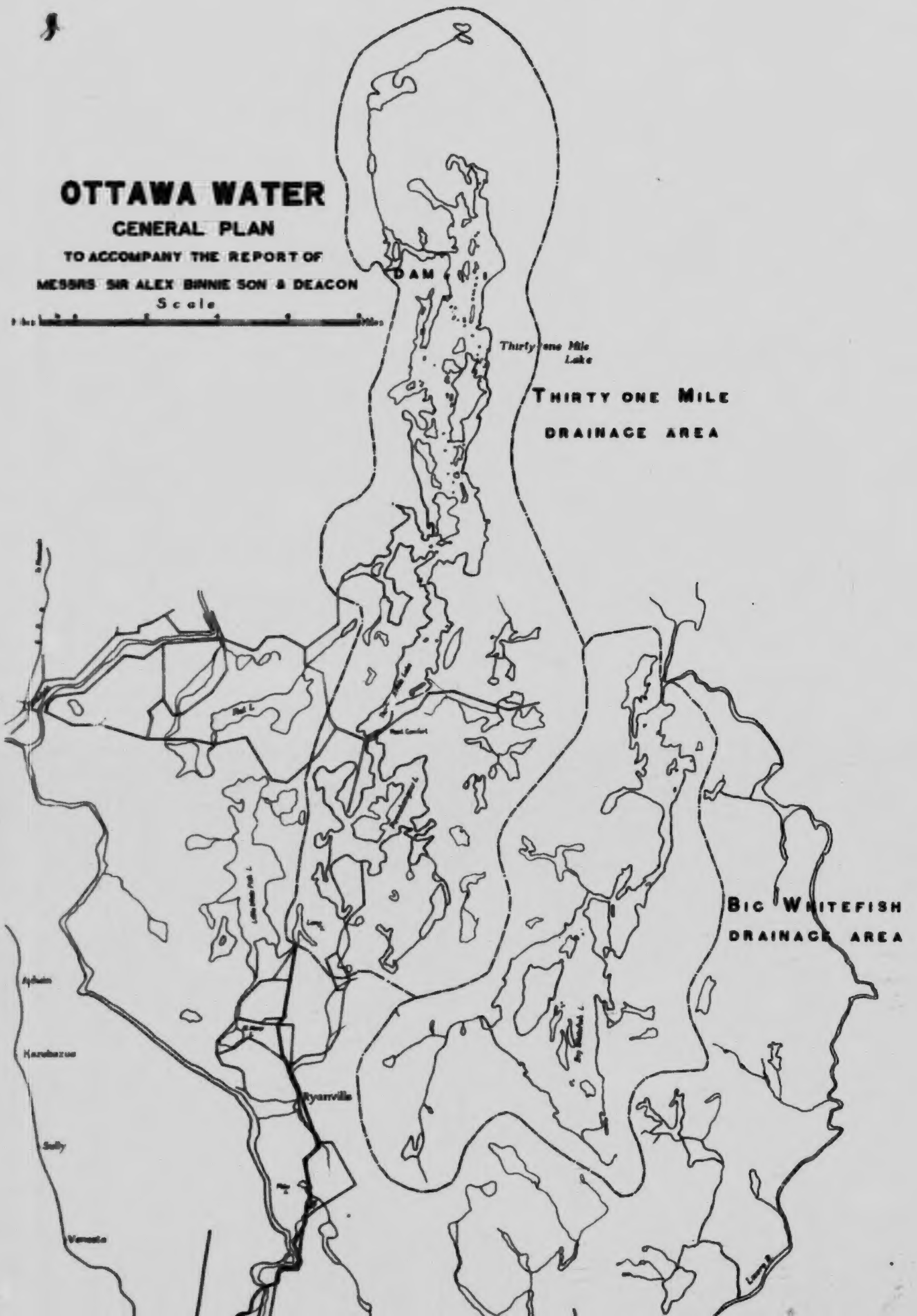
tion

by-
i of

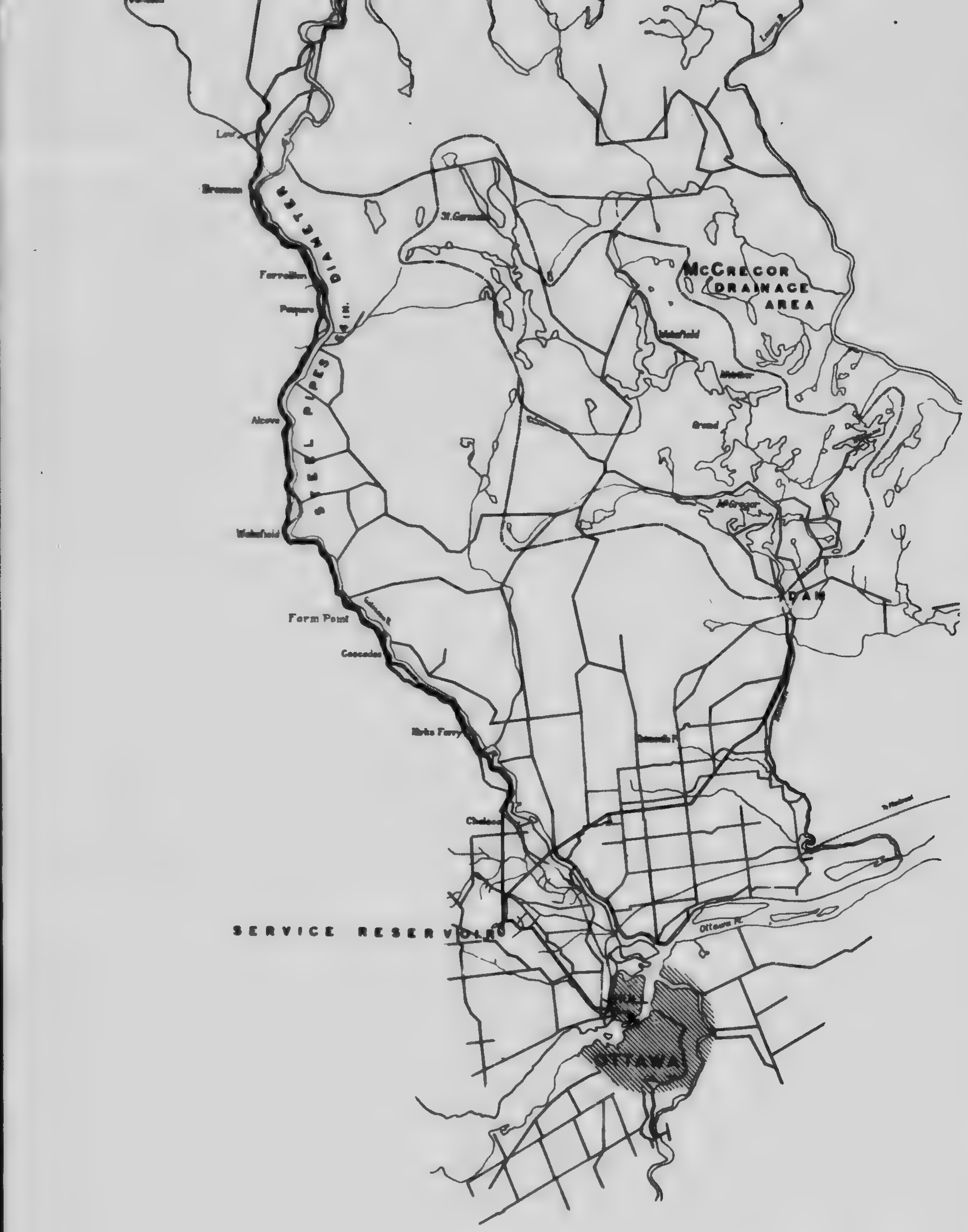
om-
t is
ing
uld

be
eal

ne
y



OTTAWA WATER
GENERAL PLAN
TO ACCOMPANY THE REPORT OF
MESSRS. SIR ALEX BINNIE SON & DEACON


Low
Brennan
STEEL PIPES 54 IN. DIAMETER
Farrellton
Paugan
Alcove
Wakefield
Form Point
Cascades
Kirks Ferry
Chelsea
SERVICE RESERVOIRS
St. Germain
McGREGOR DRAINAGE AREA
Wakefield
Meach
Grand
McGregor
DAM
To Montreal
Ottawa R.
OTTAWA

OTTAWA WATER SUPPLY FROM THE GATINEAU LAKES.

REPORT BY SIR ALEXANDER R. BINNIE.

Gentlemen,

In accordance with instructions received through the High Commissioner in England, I visited Ottawa in company with Mr. Houston in the month of February this year in order to advise you with regard to the steps which should be taken to improve the water supply of the City. After careful consideration we came to the conclusion, which is embodied in our report dated the 10th of February, 1913, that you should abandon the Ottawa River and obtain your supply from an uncontaminated source such as is afforded by the lakes lying between the Gatineau and Lievre Rivers. We visited Thirty-one Mile Lake and samples were taken which showed that if this water could be secured the City would be in posession of one of the finest sources of water supply known to us.

Owing to the absence of contour maps showing the levels of the various lakes and the configuration of the country it was impossible at that time to prepare any definite scheme or to give a proper estimate of cost. I advised therefore, that proper surveys should at once be undertaken which would permit of definite conclusions being arrived at.

It was accordingly arranged that the Dominion Government should undertake the necessary survey and that I should send out a representative who would be able to direct the surveyors so that the information necessary to prepare a scheme of water supply from the Gatineau lakes should be obtained.

In accordance with this arrangement Mr. Legg left England on the 18th of April and has spent six months investigating on the spot and obtaining the information which I required. In accordance with the resolution passed by the City Council on May 5th, I was requested to visit Ottawa as soon as the necessary surveys, etc., were completed in order to furnish you with my definite recommendations. Owing to an operation which I had to undergo on the 15th of July, involving the amputation of the left leg, it was impossible for me to make this contemplated visit. Mr. W. R. Tickell, who is an engineer of great experience in these matters, was to have accompanied me, and as I was unable to come myself I suggested that my son and partner, Mr. W. J. E. Binnie, who has also had wide experience in waterworks engineering, should go out instead of me. This suggestion was adopted by the City Council and in accordance with instruction dated the 25th of July, these two gentlemen arrived in Ottawa on August 29th, at which date the surveys, etc., had been sufficiently advanced to permit of the preparation of the scheme which would be accompanied by full and definite particulars. These two gentlemen, together with Mr. Legg, have made a thorough investigation of all the sources of water supply which will be dealt with, and have made a detailed examination of the proposed routes for the aqueducts, including the service reservoir, and have determined the site of all the necessary works.

The information obtained has been sent home to me for my consideration and I shall now proceed to deal with the whole question.

PROVISION WHICH SHOULD BE MADE FOR THE FUTURE.

The present rate of water consumption in Ottawa is very high, being about 175 gallons per head per diem calculated from the pumping records after allowing 6½ per cent for the slip of the pumps.

From an examination of the statistics kept by your Water Engineer I have come to the conclusion that not more than 59 gallons per head per diem is actually used and that the rest is wasted by leaky pipes and house fittings.

The average rate per head in other Canadian cities that have a population of 50,000 persons or over is as follows:—

(Report of Commission of Conservation, 1912.)

City.	Population.	Consumption per diem.	Rate per hundred per diem.
Montreal	580,000	67,800,000	117 gals.
Toronto	425,000	42,132,000	99 "
Winnipeg	175,000	8,000,000	46 "
Vancouver	125,000	17,000,000	136 "
Hamilton	85,000	10,500,000	123 "
Quebec	75,000	10,000,000	134 "
Victoria	50,000	4,000,000	80 "
	1,515,000	150,432,000	105 approx.

The consumption varies from 136 to 46 gallons per head per diem and is lowest in the two cities, Winnipeg and Victoria, where water is sold by meter and the consumers have therefore to pay for all the water which is wasted in the house.

The average rate of consumption per capita is six times that of London, but the conditions are such as to render it necessary to make a very ample provision. By a thorough system of inspection and vigorous enforcement of by-laws for the prevention of waste, coupled, with a thorough examination and repairs of the existing distribution system, I am of opinion that the water supply per capita can be reduced in Ottawa to 100 gallons per head per day.

On this assumption I have considered the capability of the various sources of supply to provide 25,000,000 gallons per diem or sufficient for 250,000 persons, keeping in view that the source of supply should be ample to provide for a possible future population of 750,000 persons.

An experience gained in the study of this particular subject extending over 50 years of professional life, has shown that on the introduction of a gravity supply the efforts to reduce waste have been relaxed. The reason of this is obvious; as the water comes down by gravity, and there is therefore no apparent economy in attempting to reduce waste. The time will then rapidly arrive when the limits of the first installment of a gravity scheme are nearly reached, and in order to attempt to postpone the heavy additional financial burden represented by the introduction of the second installment efforts are made to reduce waste. These efforts, though to a certain extent successful, are not sufficient to get down the waste, and the inevitable introduction of the additional water supply is brought about by a rapidly increasing population much sooner than should have been the case. The reduction of waste and leakage in a large city like Ottawa is not an undertaking which can be carried out in a short time; it takes years of careful work to bring it about and unrelaxed attention to keep the consumption at a low figure.

I wish, therefore, to place on record that it is, in my opinion, most urgent that the City should use every effort to bring down the rate per capita to a reasonable figure so as to enable a water supply of 25 million gallons per diem to serve a population of 250,000 persons and postpone in that way the time when it would be necessary to augment the supply.

GATINEAU LAKES.

A preliminary examination indicated that there were two possible schemes which would be found to afford sufficient water to meet future requirements.

These schemes are:—

1. To take water from Thirty-one Mile and Pemichangaw Lakes.
2. To take water from the McGregor Lakes.

These sources of supply are shown on the general map which accompanies this report.

THIRTY-ONE MILE LAKE AND PEMICHANGAW LAKE.

These two lakes are situated on the east bank of the Gatineau River at a distance of about 40 miles to the northward measured in a straight line from Parliament Hill to the south end of Pemichangaw. The surrounding area of land which drains to these lakes is dotted with numerous other smaller lakes, but the above mentioned are the only lakes of any importance and extent.

Quantity of water which can be obtained from this source.

The quantity of water which can be derived from any given drainage area depends on three factors:—

1. The extent of the drainage area, which in this case would be 150 square miles approximately;
2. The quantity of rain or snow which is annually precipitated on that drainage area; and,
3. The proportion of the precipitation which flows from the ground and can be collected, known as the run-off.

Rainfall.

There are no rain guages within the drainage area, nor within a long distance from it. The nearest guages being situated at Lucerne and Perkins Mill, about 25 miles to the southward. I have not been able to obtain reliable information with regard to the former guage, but the readings at Perkins Mill, which appear to have been carefully kept, indicate a higher rainfall during the two years commencing May 1911, when the guage was established, than that at Ottawa. The average rainfall registered at the Experimental Farm between the years 1892 and 1912 inclusive, amounted to approximately 35 inches per annum. The period of observation is too short for fixing a true average and comparing this guage with the guage whose records were published by the Department of Marine and Fisheries in 1906 and which has been kept since 1875, it would appear that the true average is about 34.2 inches. The total rain and snow recorded at Perkins Mills during the year 1912, amounted to 44.57 inches as against 41 inches at the Experimental Farm. The true average at Perkins Mill would thereforte appear to be

$$34.2 \text{ x } \frac{44.37}{41} = 37 \text{ inches approximately.}$$

These figures appear to show that the rainfall is higher as we go northward. Although the records are too scanty to justify any figures based on such an assumption at the same time I am of opinion that an average precipitation of 37 inches per annum may be taken for this drainage area taking into account its elevation and general character.

Run-off.

There is very little information available regarding the percentage of run-off from rainfall in the vicinity or indeed in any part of Canada, but certain observations were made in connection with the Georgian Bay Ship Canal project which are, to some extent, applicable. These are fully dealt with in the Sessional Paper 19-A of the Report. The area on which the observations were made was the drainage area of Lake Talon near the head of the Ottawa River. Its latitude is practically the same as that of Thirty-one Mile Lake whilst in the longtitude it is only some 150 miles west and the elevation of Lake Talon is about 100 feet higher than Thirty-one Mile Lake. The following description of the nature of the drainage area as given in the report, page 197, would apply equally well to the drainage area of Thirty-one Mile and Pemichangaw.

> "Almost the entire drainage area above the outlet of Lake Talon "is heavily wooded. In the vicinity of Bonfield and Rutherglen and in "one or two isolated places there is some farming but only to a very "limited extent, and probably not more than three per cent of the entire "drainage area is cleared. Some of the area not now cultivated might "be improved in the future but most of it is not suitable for cultivation "and it is unlikely that any material change will take place in the charact-"er of the watershed."

The area thus described consisted of a total of 342 square miles about 24 of which were open water and 318 land. For the purposes of investigation 6 rain guages, two evaporation guages. and several river guages were fixed which were read daily from April 1905 till November 1906. The results are given in Tables 4 and 5, page 218 to 239, and plate 29 of the Report. The figures show that for the whole period of 21 months during which the observations were continued, 51.6 per cent of the rainfall flowed off and that for the twelve months. March 1905 to February 1906, 57.1 per cent flowed off, whilst for the twelve months, November 1905 to December 1906, 44.9 per cent flowed off. It would appear that the percentage of run-off given represents the run-off from the whole catchment area of land and water and that the annual loss by evaporation was about 15 inches. This figure is confirmed by the records of flow of the Ottawa River which have been kept at Besserer's Grove, about 9 miles below Ottawa, since the year 1867, and which are also published in the Georgian Bay Canal Report. The evaporation from the water surface of Lake Talon is given in the Table on page 126, and the following are the figures:—

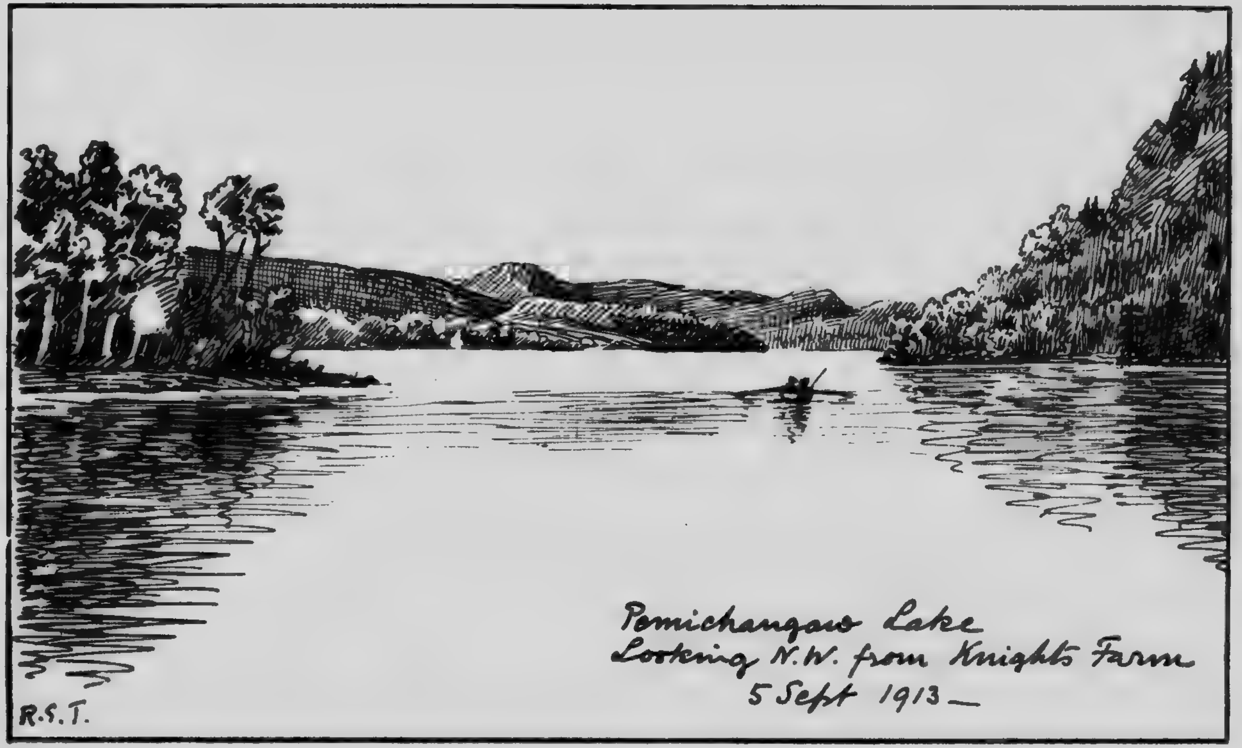
north-
ed on
ecipit-
g into

ge of
, but
Ship
dealt
h the
head
hirty-
d the
Lak .
n th
hirty-

Talon
nd in
very
entire
might
ration
aract-

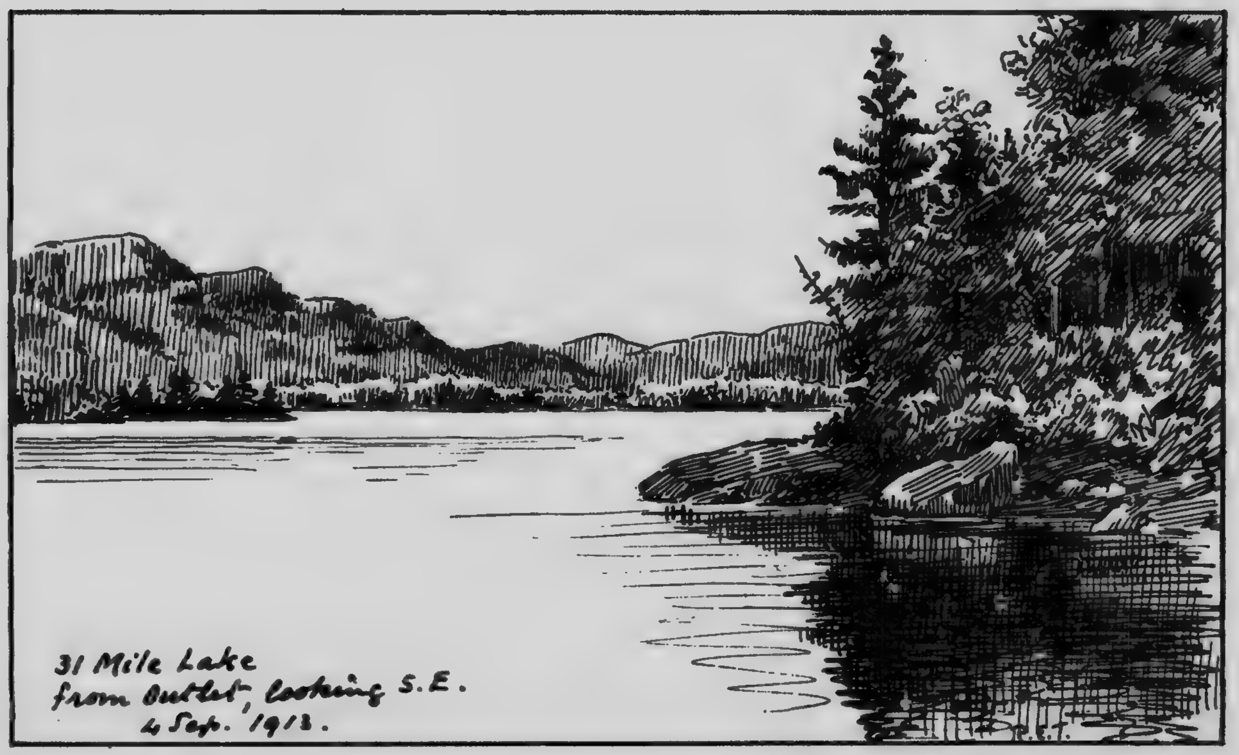
ut 24
ion 6
fixed
s are
The
bser-
at for
d off,
9 per
n re-
that
rmed
erer's
also
n the
llow-

Long Lake
Looking North
6 Sept 1913



Pemichangan Lake
Looking N.W. from Knights Farm
5 Sept 1913 –

R.S.T.



31 Mile Lake
from Outlet, looking S.E.
4 Sep. 1913.

EVAPORATION AT SURFACE OF LAKE TALON.

	Total amount for the month.		Inches. Mean of 2 Years.
	1905	1906	
January	....	....	....
February	....	....	....
March	....	....	....
April	.360	.400	.380
May	2.000	2.608	2.304
June	2.563	3.420	2.991
July	3.065	5.233	4.149
August	2.776	4.091	3.433
September	1.733	3.686	2.710
October	1.500	1.912	1.706
November	....	.745	....
December	....	....	....
	13.997	22.095	18.045

The results of these investigations may, I think, be fairly applied to the catchment area of Thirty-one Mile and Pemichangaw Lakes and show that we may safely assume an annual evaporation of about 15 inches from the ground surface and 18 inches from the water surface, or seeing that the area of water to land is about 1 to 5, an average evaporation figure of 16 inches may be taken as applicable to the whole drainage area of Thirty-one Mile and Pemichangaw Lake.

Having now arrived at a figure for the average annual rain fall and the loss by evaporation, it remains to consider those periods when the rain will be less than the average. When adequate storage is provided it is not necessary to consider the driest year as the storage in the reservoir will make up for the shortage of several years. The usual English practice is to take the reservoir as being sufficient to equalize the rainfall of the three driest consecutive years which is found all over the world to be about 80 per cent of the mean annual rain fall. The available run-off which can be depended upon on this basis is therefore as follows:—

Average rainfall	37	inches.
Deduct 1-5	7.4	"
Mean of 3 driest consecutive years	29.6	"
Deduct for evaporation	16	"
Available run-off	13.6	"

Discharge from the Drainage Area.

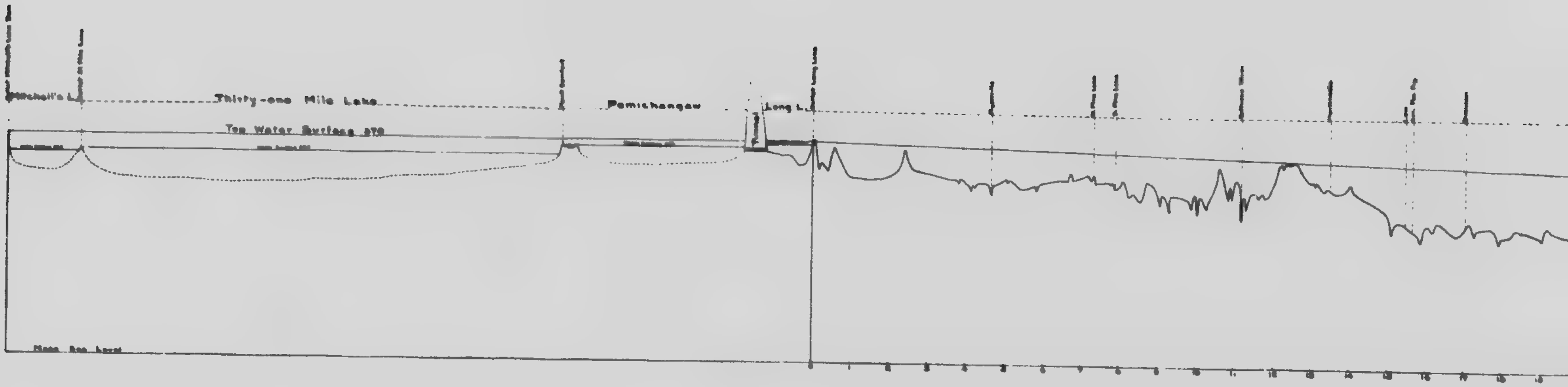
Taking 13.6 inches of rain on the catchment area of 150 square miles, the average yield would be during the three driest consecutive years approximately 81 million gallons per diem, and would, thereofre be ample to meet the requirements of a population of 750,000 persons.

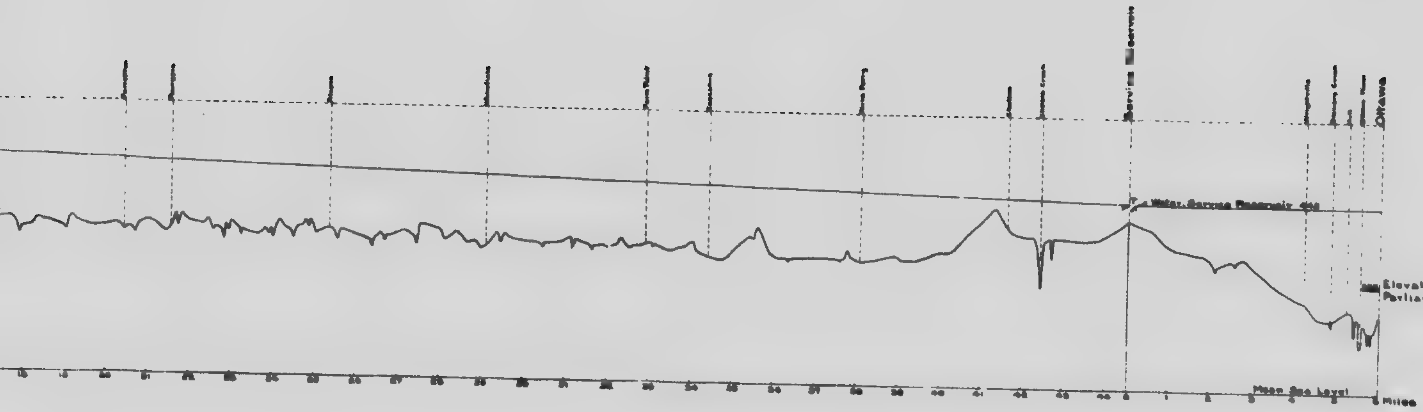
Quality of the Water.

Apart from bacteriological or chemical examination the character of a water can be very largely predicted from an examination of the drainage area. Sketches are given herewith of Thirty-one Mile Lake, Pemichangaw and Long Lake, which show the general character of the scenery. The rocks are gneiss and crystalline lime stone and are apparent at or near the surface over almost the entire drainage area which is covered with trees and undergrowth very little clearing having been done, the entire resident population amounting to only 130 persons, or less than 1 to the square mile. In addition to this resident population there are a certain number of summer visitors and lumbermen, who are at work round the lake in the early summer months. The shores shelve rapidly into deep water almost all round the lakes and the islands with which they are dotted. No soundings have yet been taken except at certain points, but we are informed that there are places in the lakes over 200 feet in depth. The drainage area has now been examined at a great number of points and has been found free from peat or other surface deposits liable to discolor the water, and the total area of swampy ground is insignificant. It might be expected that water flowing from such a drainage area would be of exceptional purity and such is the case. This water having been und observation during the whole of this year when it has always proved to bright and clear, the bottom being plainly visible at great depths. About the beginning of September certain organisms called Rhysopods make their appearance in all the lakes examined, except some of the small ones, and disappear in a short time. In appearance they resemble minute sea urchins but are plainly visible to the naked eye, and are, in fact, of such dimensions as to be readily removed by fine mesh screens. It will therefore be necessary to provide such screens at the outlet both to prevent these organisms and fish from entering the pipe. If steps are taken by the City to prevent contamination in the future by human pollution there will never, in my opinion, be the slightest necessity to filter this water, and should Ottawa adopt these lakes as a source of supply one of the finest water supplies in the world would be secured.

Method of Collecting and Storing the Water.—(See Section.)

There are four lakes which form a chain stretching approximately north and south. Commencing at the north is Mitchell Lake, a small lake which discharges through a narrow gorge at its outlet into a channel which finds its way into the Gatineau. This lake has a surface area of .7 square miles, and water level in September was 523 feet above datum. It receives the entire discharge of Thirty-one Mile and Pemichangaw, and a narrow rocky gorge already referred to forms an admirable site for a dam. The next in the chain towards Ottawa is Thirty-one Mile Lake which is about 18 miles in length with a water area of 18 square miles, the water level this summer being about 530 feet above datum. Immediately to the south, and separated by a narrow neck of land, lies Pemichangaw with a water area of 6 square miles and a length of about 5 miles, the water level this summer being about 552 feet above datum. Crossing the height of land to the southwest of Pemichangaw we come to Long Lake, having a length of about 1¼ miles, and a water area of about one quarter of a square mile. The distance between Pemichangaw and Long Lake is about 3,000 feet, and the water surface of Long Lake is 561 feet above datum. It is proposed to tunnel through the ridge between Pemichangaw and Long Lake and by means of the dam at the outlet of Mitchell Lake to bring all the lakes to one level, namely, 570 feet above datum, and to start the aqueduct to Ottawa from the south end of Long Lake. This would mean raising Mitchell Lake 47 feet, Thirty-one


Mitchell's L.
Thirty-one Mile Lake
Pemichangan
Long L.
Top Water Surface 870
Mean Sea Level



OTTAWA WATER
THIRTY-ONE MILE LAKE PROJECT
PROFILE OF
LAKES & PIPE LINE

Horizontal Scale
Vertical Scale

Mile Lake 40 feet, and Pemichangaw Lake 18 feet. The contour surveys to determine the top water area at this level are not yet completed, but it may be roughly assumed that the total top water area of the lakes when brought to this uniform level of 570 feet above datum will increase to about 35 square miles in area. One foot difference in level of a water surface having an area of 35 square miles represents about six thousand one hundred million gallons, and 18 inches would give a year's storage of a daily flow of 25,000,000 gallons, 3 feet would give sufficient storage for 50,000,000 gallons per diem, and 4 feet 6 inches sufficient for 75,000,000 gallons per diem. The maximum variation in water level would therefore be small.

Dam at Mitchell's Lake.

This dam would be designed so as to overflow at a height of 570 feet, the total contents of masonry to this level being estimated at about 9,100 cubic yards. Timber is being cut in the forest surrounding Thirty-one Mile Lake, the logs being floated down to the Gatineau by way of Mitchell Lake and the channel below that Lake. As the time will not arrive for many years when it might become necessary to consider the acquisition of these lumber rights in order to conserve the whole of the available water for the supply of the City, I have based my estimate on the assumption that those rights are not now acquired and that provision will be made for the necessary regulating sluice and chute for passing the logs from the lake into the stream below.

Clearing ground which will be submerged.

I have assumed in the estimate that the area now surrounding the lake which will be submerged when the water rises will be cleared, such timber as saleable being removed, and the remainder, including the undergrowth, cut and burnt. This does not include grubbing up the roots which will be charred, as I do not consider charred roots will have any effect on the quality of the water.

Rate of filling of the lakes up to the top water level and steps to be taken to afford immediate supply.

It has already been stated that the dam would be constructed so as to raise the level of the lake to 570 feet above datum which means that Thirty-one Mile Lake would have to rise 40 feet, and Pemichangaw 18 feet. Owing to the enormous area of Thirty-one Mile Lake it would take five or six years before this lake would rise even to the level of Pemichangaw, that is 22 feet, and ten or twelve years before it reached the final level of 570 above datum. It is obvious that the scheme should be so laid out as to enable water to be brought forward to Ottawa as soon as the aqueduct and service reservoir can be completed, which can be effected in the following manner:—

Pemichangaw and Long Lake to be first drawn upon.

Pemichangaw and Long Lake have a total drainage area of about 41½ square miles and would yield on the basis of a run-off of 13.6 inches about 22½ million gallons per diem, or sufficient for the needs of the City for a good many years. The level of Pemichangaw Lake varies between about 554 and 552 feet above datum, and the Lake is separated by a narrow neck of land known as Point Comfort from Thirty-one Mile Lake which is about 30 feet lower in level. This neck of land acts as a natural barrier which retains water at the higher level in Pemichangaw, and is traversed by a narrow gorge through which the water is discharged into Thirty-one Mile Lake. This gorge is blocked by a wooden dam provided with sluices and the fall of water from one lake to the other is utilized for a sawmill. Water also finds its way into Thirty-one Mile Lake from Pemichangaw through debris overlying the rock filling the bottom of what no doubt was at one time a valley of discharge from one lake to the other. I was informed that there were underground fissures connecting the two lakes, and the measurements which have been taken this summer show that when the water level in Pemichangaw stood at 554 feet above datum the amount of water which got through this debris or surface fissures in the rock amounted to approximately 8,000,000 gallons per diem; but when the water level in the lake had fallen to 552 datum the discharge was very small indeed, showing that the water was really finding its way from one lake to the other through a comparatively shallow channel. Of course there may be some deep underground fissures which would be incapable of detection, but there is no doubt that any water lost by them is insignificant provided the present level of the lake is not materially altered. I should therefore propose as one of the first steps to be taken to open a trench acros the old channel and fill this concrete so as to cut off the water now leaking away through the debris when the water level is raised to 554 feet above datum, and to make a water tight dam in lieu of the existing leaky dam which holds up the water for the mill. These works would enable the water to be retained in Pemichangaw Lake and the City could draw upon that lake as soon as the aqueduct was completed. The present water area of Pemichangaw is about 6 square miles and 5 feet in depth on that area would represent the total storage required for the first installment of 25,000,000 gallons per diem. Assuming that the minimum draw-off level was to be 549 feet above datum or 3 feet below the present level, the maximum level at which the water would overflow be 554 feet above datum. Although in this way the storage required for the first installment would be provided it must always be borne in mind that Thirty-one Mile Lake will take years to be brought up to the level of Pemichangaw, and it must not be forgotten that on the basis of my figures the Pemichangaw area will not quite yield sufficient for the first installment of 25,000,000 gallons or as much as the aqueduct will carry, and the sooner Thirty-one Mile Lake is brought up in level the better.

The dam at the outlet of Mitchell's Lake should therefore be proceeded with as soon as the necessary arrangements could be made so that Thirty-one Mile Lake can be gradually raised to such a level as to flow towards Ottawa by means of the aqueduct. I have therefore included in the estimate for the supply of 25,000,000 gallons the cost of the dam at Mitchell's Lake, and also the necessary clearing to bring Thirty-one Mile Lake and Pemichangaw Lake to the level of 570 feet above datum when storage will be provided for the full yield of the drainage area or 81,000,000 gallons a day.

Tunnel between Pemichangaw and Long Lakes.

To bring the water of Pemichangaw into Long Lake from which lake the aqueduct would start, will necessitate constructing a tunnel through the height of land between the two lakes, a distance of about 3,000 feet, as already pointed out. This tunnel should be made about 7 feet internal diameter so as to permit of the whole available yield, namely, 81,000,000 gallons per diem being passed through into Long Lake without appreciable loss of head.

The best location for the invert of the tunnel would be about 6 feet below the present level of Pemichangaw or at about 546 feet above datum, 24 feet below top water level when brought up to 570 feet above datum.

This tunnel would terminate at each end in covered shafts, the water entering the shaft at the inlet end and leaving the shaft at the outlet end well below the water level of the respective lakes.

In this way there would be no danger of the water in the tunnel freezing even if the lakes were drawn down to the level of 549 feet above datum, which is the minimum draw-off level, during the construction of Mitchell's dam and during the period while the lakes are filling up to 570 feet above datum.

In order to enable the tunnel to be driven from an open face to obviate the necessity of pumping any water which may be met with, and also to facilitate the construction of the outlet works, it is proposed to draw down Long Lake during construction in the manner to be presently described.

Works at Long Lake.

Long Lake varies in depth from about 20 feet to 50 feet, being shallow towards the north end and deep towards the south. This lake, like Pemichangaw, is formed by a natural barrier, and the water issuing from it passes over this barrier by means of a series of small falls and cascades to the valley below, dropping 50 or 60 feet in a short distance.

A short cutting through this barrier will therefore enable the water to be drawn down 20 or 30 feet without any difficulty.

The shores of the lake are steep and rocky but at times during and after windy weather the sediment in the bottom is stirred up by wave action This action does not extend to any great depth probably not much below 10 feet. It is therefore proposed to remove the sediment, logs, etc., when the lake is drawn down so as to prevent similar action taking place in the future.

Outlet works.

These works would consist of a straining tower about 50 feet high, covered at the top and provided with copper gauze screens; the water entering the tower at a depth of 7 or 8 feet below the minimum water level of the lake and after passing through the screens leaving by means of a culvert through the natural barrier already referred to, to the commencement of the pipe. It is proposed to install a small water-driven turbine so as to work a pump for supplying high pressure water for washing the screens. The power for this turbine would be supplied by allowing water to pass from the lake to the valley below, the turbine being situated at the foot of the fall which has already been referred to. The screens would be made so that they can be lifted in rotation for cleaning purposes without interfering with the flow of water and the dirty water, after cleaning, would be discharged into the valley below the straining tower.

PIPE LINE.

Description of Pipe.

The ultimate top water level of the lakes has already been given, namely, 570 feet above datum.

The top water level of the service reservoir which will presently be described, would be 445 feet above datum. The distance between the outlet and the service reservoir is about 235,000 feet and allowing for losses of head at the reservoir the hydraulic gradient would be approximately 1 in 1960, and with this gradient a welded or lock-bar steel pipe, 54 inches in diameter, would deliver 25,000,000 gallons a day allowing for future encrustatiôn. If rivetted steel pipes were used the internal friction is slightly greater on account of the rivet heads and the diameter of the pipe would be slightly larger to discharge the same quantity of water. The estimate has been based on approximate quotations received for 54 inch welded steel pipe, 7-16ths of an in thickness. With soft water considerable encrustation may be anticipated, but seeing that the Thirty-one mile Lake water contains about four and a half grains of lime per gallon it is probable that this may not take place to any appreciable extent. The Ottawa River water contains about two and a half grains per gallon and appears to have had very little effect on steel pipes which were laid many years ago without any protection by means of coating. It has been found that steel pipes are also liable to corrode from the outside if laid in saline or marshy ground unless special precautions are taken. The best protection in such cases is to surround the pipe with tarried hessian or jute, and provision has been made in the estimate for this precaution where the pipes would be located in swampy ground. To prevent freezing in winter the pipes should be laid so that the bottom would come a minimum of 8 or 9 feet below the surface of the ground, and the estimate has been got out on this assumption.

Route of the Pipe.

This is shown on the plan. After leaving Long Lake the pipe would pass southward gently undulating cultivated land for a distance of about one mile until a cedar swamp is reached which would have to be traversed for a distance of another mile when open cultivated land is again reached about two miles north of Ryanville. The ground is of much the same character between Ryanville and the Gatineau, which would be crossed at a point about 11 miles south of Long Lake by means of a bridge having a span of 150 feet. The estimate has been got out on the assumption that provision is made for two pipes across the bridge, each to be able to carry 25,000,000 gallons per diem, and the pipes would be housed in and surrounded with sawdust or some other suitable insulating material to prevent freezing in Winter where they are brought over the bridge. After crossing the Gatineau the pipe would proceed in a south-westerly direction joining the C. P. R. about half a mile south of Low Station, passing through cultivated land and another cedar swamp between the river and this point.. The total length of the pipe from Long Lake to the C. P. R. being about 16 miles. The distorted section gives rather a false impression of the country which is in reality gently undulating and an easy route for a pipe track such as this, The haulage has been assumed for the portion of the track from depots at Kazabazua and Low stations; the pipes to be brought to the side of the trench on sleds during Winter; the distance from Kazabazua to Long Lake being about 14 miles by road. From Low as far as Chelsea, a distance of about 24 miles, the pipe track would be in close proximity to the C. P. R. and this portion of the route would not be so easy from the point of view of pipe laying. A good number of minor works, such as bridges, stream crossing and culverts being required. At Chelsea the pipe would leave the C. P. R. and proceed nearly due south passing close to Old Chelsea to the service reservoir, a distance of about four and a half miles. The service reservoir is located in the hills about two and a half miles south of Old Chelsea and four miles northwest of Hull. The portion of the track between the C. P. R. and the service reservoir would be through cultivated land.

Service Reservoir.

The function of this reservoir is two-fold:—

1. To provide against a water famine in the town should the water have to be cut off in the aqueduct to allow of repairs being executed.
2. To meet the daily fluctuations in demand as the water supplied to a town varies throughout the day, the maximum draught

or peak load being nearly twice the average. A reserve must also be available in case of fire.

Supposing no service reservoir were provided it would be necessary to lay two pipes all the way from the source of supply in order to be able to shut off one line while the supply was kept up by the other. It is far more economical to lay out a gravity scheme of this nature so as to include a service reservoir of ample size than to lay a duplicate main when the aqueduct is long and a good site can be found for the reservoir at a suitable level. Fortunately a good site at a suitable level has been found where the water would be stored in a basin having a flat bottom and surrounded by hills. The whole of the bottom of the valley has been cleared and cultivated, and there is one farm which would have to be purchased. The estimate includes for the stripping of the whole of this area to remove vegetable impurities which might tend to deteriorate the water. With the exception of this farm the area which drains naturally to the basin is devoid of human habitation and the hills are steep rocky and covered with trees. A stream now passes through this basin and supplies water to farms lower down. This stream should be diverted round the reservoir as it would otherwise be held up in the reservoir and the farms below would be deprived of some of their water. The bottom of the reservoir varies from about 410 to 416 feet above datum and by means of three small dams the water would be held up to a level of 545 feet above datum. The water area would be about 54 acres and one foot in depth would represent approximately 15,000,000 gallons. The probable variation in water level to meet the daily fluctuation in demand would therefore be less than one foot. The contents of the reservoir between the level of 420 and 445 feet above datum would amount to about 295,000,000 gallons and represents a reserve of about 12 days supply which is very ample when compared with what is allowed by other cities. The average number of days supplied in the service reservoir of the large towns in England is from three to four days reserve. The static pressure given by this reservoir would represent 118 pounds at the pumping station or 81 pounds at Parliament Hill, and is about the maximum pressure that the house fittings would stand in the lower parts of the City.

Pipes from the Service Reservoir to the City.

These pipes should be designed so as to be able to discharge for short periods during the day a much larger quantity than the pipes from the source to the service reservoir for the reasons which have already been given. The maximum rate of consumption is taken at 110 gallons per head per diem and if unavoidable waste is added to this, say 40 gallons per head per diem, the total maximum rate of consumption would amount to 150 gallons per capita per diem. To this should be added the amount required for say 25 fire streams which would be equivalent to a rate of discharge of another 36 gallons per head per diem, so that the pipes should be designed so as to be capable of discharging 186 gallons per capita per diem as a peak load. On the basis of a population of 250,000 persons the above rate would represent a discharge of 46½ million gallons per diem. Two 51 inch pipes would deal with this peak load so that when the population increased to 250,000 persons the pressure would not fall below 110 pounds at the existing pumping station even should a serious fire occur during the period when the maximum demand was being made for water for domestic purposes.

Route of the Pipe.

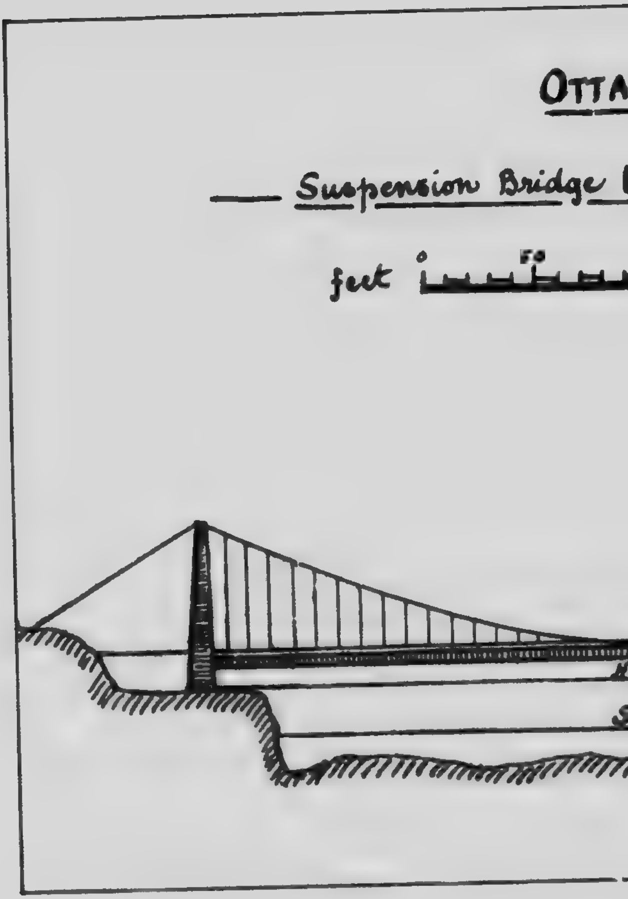
After leaving the service reservoir the pipes would be laid through cultivated land to the west side of Hull station so as to cross under the proposed

Georgian Bay Canal below the level of the bottom of that channel. If the canal is constructed culverts should be provided by the Canal Company at some future date to surround the pipe under the bed of the canal and allow them to be always visible for inspection. The pipes would then cross Brewery Creek about the site of the existing bridge at the end of Wright Street, and would pass through Hull till the bank of the Ottawa River is reached at a point about 1,400 feet east of the Union Bridge.

Crossing of the Ottawa River. (See Sketch of Suspension Bridge.)

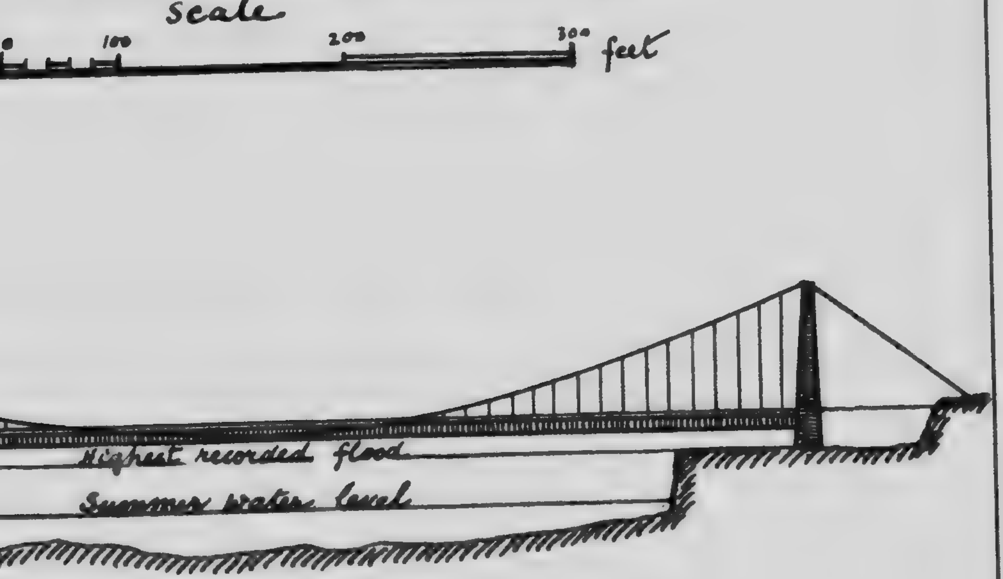
I have directed considerable attention to the question of this river crossing and various routes have been investigated. The one finally selected for the purpose of the estimate being that shown on the plan. I am emphatically of the opinion that the pipes should be carried over the various channels at this point on bridges, as if the pipes are carried over a bridge it is an easy matter to inspect and maintain them in good condition, but once they are laid in the river bottom it is a very different matter. Another method which is equally effective is to construct a tunnel under the river and to lay the pipes through this tunnel. I am adopting this latter method in the cossing of the River Dee on the aqueduct from Wales to Birkenhead and have considered the possibility of crossing under the Ottawa in the same manner. The rock, however, is full of joints and I should anticipate considerable difficulty owing to the amount of water which would be met with in driving the tunnel under the river, so I have come to the conclusion that it would be better to pass over and not under the river. There are four channels which would necessitate first,—a bridge about 300 feet long on the Hull side of the river, then a bridge 500 feet long over the main channel of the river, then two short spans, one of 80 and one of 120 feet, the latter crossing the tail race canal from the present pumping station.For the longest spans 500 feet and 300 feet in length, it is proposed to carry the pipes on suspension bridges which can be made light and elegant in design at a smaller cost than any other form of bridge for these spans. Changes of temperature cause the decking of such bridges to rise and fall considerably at the centre of the span and allowance for this will of course have to be made by the employment of a special form of joint to prevent racking of the pipes. In order to prevent the freezing of the water in the pipes where they would be exposed to the air, I have considered the alternative of insulating them with a sufficient thickness of material and of carrying them within a light timber structure or shed, special provision being made to warm the air inside the shed in Winter. The latter alternative permits of a lighter and cheaper bridge for the long spans and I have therefore based the estimate on this assumption. Where the pipes cross the two narrow channels the box girder form of bridge would be suitable, the pipes being laid in the interior of the box girder and for such short spans I do not anticipate that any special provision will be required for heating. A section is shown which would give an idea of the appearance of the longest of the suspension bridge crossings, namely, that over the main channel of the river, and the estimate is based on the assumption that handsome masonry piers will used to support the suspension chains at each bank. It would not surprise me to learn that at no distant date it was considered advisable to reconstruct some of the structures in connection with the Union Brudge and the question of a new bridge joining Hull and Ottawa would come up for consideration. If this becomes a question of practical politics in the immediate future it might be advisable to consider the road bridge and aqueduct as one problem as the actual cost to increase the strength of the bridges so as to carry a road way as well as the pipes would not be large. This would probably lead both to alterations in the position selected for the river crossing of the aqueduct

Various smaller stream crossings and culverts	110,000


OTTA
— Suspension Bridge (
feet 0 50
H
S

OTTAWA WATER

idge to carry mains over Ottawa River ——



and the level of the decking of the bridges. For the present I confine myself therefore to an aqueduct crossing only, the bridges being designed so as to interfere as little as possible with the existing surface of the ground and of sufficient strength to carry four 51 inch diameter pipes which would give a maximum discharge at the rate of 93,000,000 gallons per diem without material loss of head between the service reservoir and the City.

TIME OF COMPLETION OF WORKS.

The various works which would have to be constructed to bring the water from Thirty-one Mile Lake and Pemichangaw Lake to the City having now been dealt with it will be necessary to consider the time it would take for their construction. In order to reduce this to a minimum, contracts for the steel pipes should be let as soon as possible so as to permit of delivery being commenced in the spring of next year. Before detailed contract drawings are prepared further sections and plans will be required and trial pits and borings would also have to be made. If these were pushed on with at once, a sufficient staff being employed, the information could be obtained before Winter set in. This would allow of the necessary drawings, quantitiy and specifications being prepared during the Winter so that contracts could be let for pipe laying, etc., and work started in the spring of 1914. I am of the opinion that it would take three working seasons to lay the pipe and complete the necessary auxilliary works so that water could be brought in by 1917. Any delay now would mean that water could not be brought in from this source before 1918.

ANNUAL WORKING EXPENSES.

These would be small and would not amount to more than $15,000 per annum to cover the cost of looking after and cleaning the screens at Long Lake providing a keeper at the service reservoir, various watchmen along the line, and a gang which could be employed at any point.

SUMMARY ESTIMATE.

Having now considered the main features of the project it remains to give the estimate of the cost of the necessary works which is as follows:—

Head Works.

Dam at outlet of Mitchel's Lake to raise water surface to 570 feet	130,180
Clearing and burning area to be submerged	128,000
Tunnel between Pemachangaw and Long Lakes including shafts, etc.—3,000 lin. ft.	119,630
Outlet works at Long Lake—straining tower, etc	43,660
Smaller works about lakes, including subsidiary dams at depressions in height of land, temporary works at Pemachangaw, lowering and clearing Long Lake, etc	72,000

Aqueduct to Service Reservoir.

54" Steel Main 7-16" thick between outlet tower and service reservoir—235,000 lin. ft.	4,314,080
Bridge on Gatineau River	30,000
Various smaller stream crossings and culverts	110,000

Service Reservoir.

Dams	212,150
Clearing and stripping site	21,460
Inlet and outlet works	26,600

Aqueduct Service Reservoir to City.

51" steel main 7-16" thick between service reservoir and City—two lines of pipe each 32,000 lin. ft	1,101,120
Various smaller stream crossings, culverts, etc	20,000
Bridge across the Ottawa River	180,000
Total for Works	$6,508,880
Add 15% for engineering and contingencies	976,320
	$7,485,200
Land, Lakes, compensation and Wayleaves as per Mr. Gendron's estimate	500,000
Total estimate	$7,985,200

McGREGOR LAKE SUPPLY.

By the term "McGregor Lakes" are known a large number of lakes which are situated at distances varying from about 15 to 30 miles to the north of Ottawa and lying about mid-way between the Gatineau and the Lievre Rivers. They are small when compared with Thirty-one Mile Lake, the largest being McGregor which has an area of 2.13 square miles or about one-ninth of the area of Thirty-one Mile Lake. Mr. Hazen in his report, dated the 10th of May, 1910, gives a table setting out various lakes, 37 in number, and their areas, which either discharge into the Blanche River by way of McGregor or the waters of which can easily be diverted into that lake,—

McGregor, with an area of 2.13 square miles,
Wakefield, with an area of 1.47 square miles,
Grand, with an area of 1.37 square miles, and,
St. Germains, with an area of 1.12 square miles,

are the only lakes of any size; the others enumerated varying from about a square mile to a few acres in extent.

Quantity of water which can be obtained from this source.

The drainage area which contributes, or which can economically be made to contribute, to the water flowing from McGregor Lake into the Blanche River amounts to about 94 square miles.

I have already explained, when dealing with the Thirty-one Mile Lake project, that the rainfall which was taken as applicable to that area was derived from the guage which has recently been established at Perkins Mill, although the probability was that this guage would give rather too low a figure for the Thirty-one Mile area.

Perkins Mill lies within a mile of the proposed site of the dam for impounding the water of the McGregor Lakes and probably the record of this guage would represent with greater accuracy the rainfall on the McGregor drainage area than that on the Thirty-one Mile Lake drainage area. I have, therefore, taken the same figure, namely 37 inches, as representing the average rainfall, and have assumed the same figure for evaporation from which the figure of 13.6 inches is arrived at as representing the run-off during the three driest consecutive years as being applicable to both Thirty-one Mile and McGregor areas.

Taking a drainage area of 94 aquare mills and a run-off of 13.6 inches would give a figure of 51,000,000 gallons per diem as the yield of the drainage area

Quality of the Water.

In both cases the ground surrounding the lakes is for the most part rocky and covered with trees, but the hills surrounding Thirty-one Mile Lake rise to greater altitude and far more clearing has been done around McGregor Lake and Wakefield Lake; the resident population being given as between 7 and 8 persons per square mile. The effective storage in improving the purity of the surface water and in bleaching and removing the color is now very generally recognized, and it is important in this respect to bear in mind that whereas the total water area of Thirty-one Mile and Pemachangaw Lakes amounts to 24 square miles, the total area of the four principal McGregor Lakes amounts to only 6 square miles. Thirty-one Mile Lake and Pemachangaw are also lakes of great depth, whereas there is a considerable area of comparatively shallow water in the McGregor and Wakefield lakes. Taking these circumstances into consideration I should be led to expect that the water stored in Thirty-one Mile and Pemachangaw Lakes would be superior in quality to the McGregor Lake water and such is unquestionably the case.

Whereas, the water of the former lake was bright and clear in the early part of September, the water of McGregor contained a considerable amount of amorphous matter in suspension. To give an idea of the difference it may be stated that objects could be seen at three or four times the depth in Thirty-one Mile Lake to what they could in the McGregor and Wakefield Lakes; and, whereas, the water in Thirty-one Mile Lake varies but little in this respect throughout the year there is a marked increase in the turbidity of the McGregor water as the summer advances. The McGregor Lake water is of course very much superior to the Ottawa River water, but in order to render it as bright and clear at all times of the year as the Thirty-one Mile Lake water filtration would be necessary. If the McGregor Lakes are adopted as a source of supply I should also recommend that the farms and residence surrounding the lakes be purchased as there are far too many possibilities of infection of the water taking place, in fact the population in the drainage area is considerably higher than that of the basin of the Ottawa River.

FILTRATION.

The best way of treating the McGregor Lake water would be by means of mechanical filters. The cost of such filters works out at about $20,000 per million gallons treated per diem, when the filter house and various pipe work is included. It is very difficult to say what amount of coagulent would be required, but I am of the opinion that a very small quantity would be sufficient seeing the character of the water, and I have assumed that one half grain of sulphate of alumina per gallon would be sufficient as a yearly average. I should not therefore anticipate that the working expenses of the filtration plant would exceed $10,000 per annum for an output of 25,000,000 gallons per diem. The loss of head through such filters is considerable and I have found it necessary to allow twenty feet for that purpose. This has an important bearing on the lay out of the scheme.

Method of collecting and storing the water.

A skecth is appended which shows the general character of the scenery aound McGregor Lake, and I shall now consider the most economical way of laying out the scheme to meet the conditions set out above. I have already pointed out that there should be duplicate mains from the source of supply to permit of repairs being undertaken without interrupting the supply. The pipes moreover would have to be made large enough to meet the peak load and not the average load if no service pipe is provided and this would nearly double the cost of the pipe line. I have therefore assumed that a service reservoir is included in the scheme and the most suitable site for the service reservoir for the McGregor Lakes scheme would be the same as for the Thirty-one Mile lake scheme as there is no other area of ground at a suitable elevation near the City. The present water level of McGregor Lake is about 466 feet above datum, and if the water were filtered 20 feet would be lost which would reduce the pressure to 446 feet above datum or to about the same level as the top water level of the service reservoir, namely, 445 feet above datum. I should therefore propose to construct a dam at the outlet of McGregor Lake where an excellent site exists, so as to raise the water in that lake to give the necessary head. The distance between McGregor Lake and the service reservoir is 78,500 feet, and if the same hydraulic gradient is taken as for the Thirty-one Mile Lake project a pipe 54 inches in diameter would be sufficient, the loss of head in the pipe when discharging 25,000,000 gallons a day amounting to about 40 feet. Adding to this the loss of head in the filters, namely, 20 feet, the total loss between the storage and the service reservoirs would amount to 60 feet and the minimum draw-off level at McGregor Lake would be 445 + 60 = 505 feet which would mean raising the level of the present lake 39 feet. Assuming McGregor Lake can be raised 50 feet the top 11 feet could be used for storage. At this level Mr. Hazen gives the top water area as being about 7 square miles including Grand Lake, which would be raised about 4 feet in level. I calculate therefore that a dam which raised the level of McGregor Lake 50 feet would not only give sufficient head for the filters and pipes but would also provide sufficient storage for 25,000,000 gallons per day.

Here, however, comes in a difficulty. At some future date it will be necessary to increase the supply and this storage would no longer be sufficient. Another excellent site for a dam exists at the outlet of Double Dam Lake which would store water in Grand Lake as pointed out by Mr. Haren. Now this site would be under water if McGregor Lake was raised 50 feet and therefore it would be necessary to construct at all events that portion of the dam which is below water as part of the first installment. It would however be necessary in my opinion to complete the dam right away for several reasons:—

1. So as to avoid the possible chance of pollution of the water supply of the City by the large body of workmen who would have to be employed in its construction.
2. It will assist in the storing of flood water which would otherwise have to run to waste and would delay bringing the scheme into operation.
3. The water which now flows from Grand Lake into McGregor by way of Double Dam Lake is utilised to develop electric energy to work the air compressing plant for the Blackburn Mines.

It would either be necessary to compensate the owners for depriving them of this power or to provide an alternative. By constructing the dam this power can readily be given by means of the water held up at the higher level in Grand Lake discharging into McGregor. For these reasons I have included in the estimate for the supply of 25,000,000 gallons per diem a second

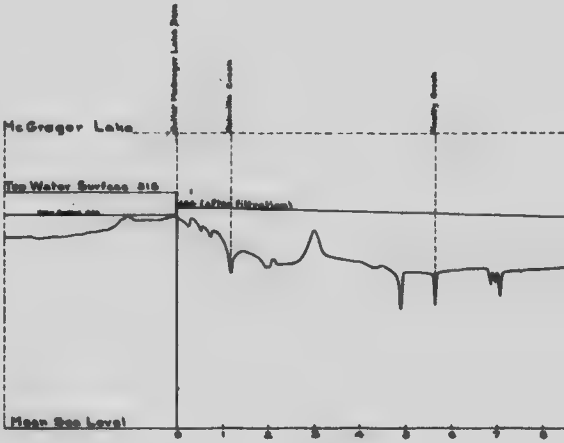
nery
y of
ady
pply
The
oad
arly
vice
vice
rty-
tion
feet
uld
l as
um.
ake
the
vice
the
ent,
cing
20
unt
-60
eet.
sed
out
in
gor
but

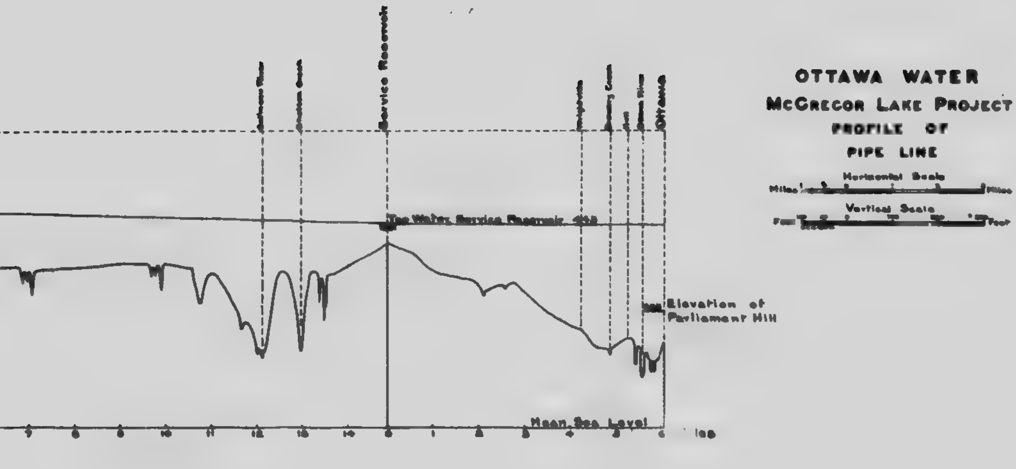
be
ent.
ake
ow
ere-
am
be
:—
ply
to

vise
ome

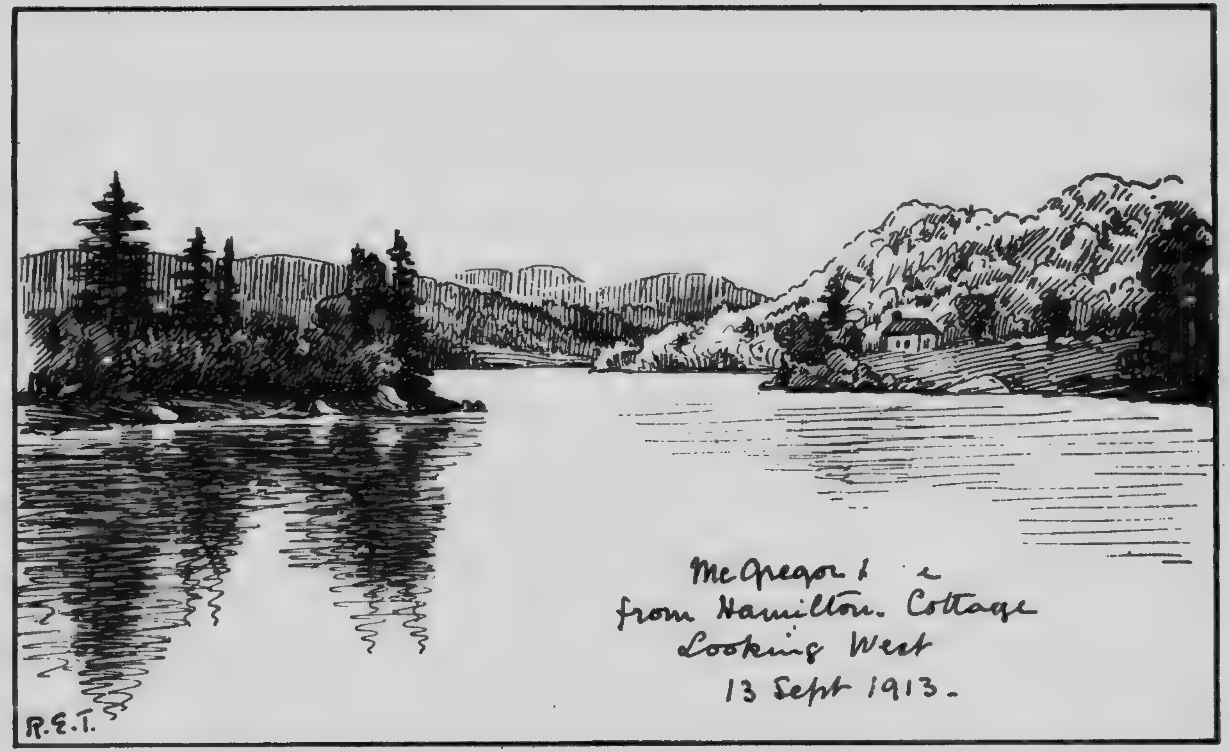
gor
tric
urn

ving
am
her
ave
ond


McGregor Lake
Top Water Surface 816
(after filtration)
Mean Sea Level
0
1
2
3
4
5
6
7
8



OTTAWA WATER
McGREGOR LAKE PROJECT
PROFILE OF
PIPE LINE



R.E.T.

McGregor I[illegible]e
from Hamilton. Cottage
Looking West
13 Sept 1913.

dam at the outlet of Grand Lake which will raise the water in that lake to 550 feet above datum and would flood back into Wakefield Lake raising the level of this lake 11 feet. The effect of the works outlined above would be to flood a very large area of land now under cultivation. In making comparison with the Thirty-one Mile Lake project it must be borne in mind that storage is there provided for the full yield of the drainage area for 81,000,000 gallons a day.

PIPE LINE.—(See Section.)

After leaving the McGregor Lake the pipe line would follow the same route as that proposed by Mr. Hazen for about 5 miles; it would then turn to the west, crossing the Gatineau River about a mile north of Wright's Bridge and would then proceed in a sothwesterly direction to the service reservoir The total length of the pipe line being 78,500 feet. The estimate assumes that the Gatineau would be crossed by means of suspension bridges having a total length of about 1,000 feet divided up into three spans, the pipes being protected from frost as already described. The first four or five miles would involve a good deal of rock cutting, but the effect of raising the level of the outlet gives an easier route just after leaving the lake and enables pipes to be carried the whole way up to the dam. The remainder of the route is through fairly easy country as far as the service reservoir. This reservoir and the pipe line forward to the city would be the same as for the Thirty-one Mile Lake project and therefore calls for no further description.

TIME OF COMPLETION.

Provided the work were put in hand at once it might be possible to bring in the water from this source by about the year 1917.

The sites for the proposed dams to impound the water of this watershed are not so favorable as that of Mitchel's Dam where the waters of Thirty-one Mile Lake would be impounded. For this reason they would take longer to construct, and although the pipe line is shorter I do not consider that the water from this source could be brought in before that date.

ANNUAL WORKING EXPENSES.

The working expenses of this scheme would be higher than for the Thirty-one Mile Lake scheme on account of the filtration expenses which I have given as being $19,000 per annum. The aqueduct being shorter would mean a saving of about $5,000 and the total working expenses would amount to approximately $29,000.

SUMMARY ESTIMATE.

Having now dealt with the main features of the project it remains to give the estimate of the cost of the necessary works which is as follows:—

Head Works.

Dam to raise McGregor Leke to 515' level with valve tower, etc.	327,500
Dam to raise Grand Lake to 550' level with outlet works	260,000
Clearing and burning area to be submerged	38,400
Road diversions, with bridges and culverts	80,000
Diversion of water from St. Germain, Battle and Rheaume Lakes	25,000
Plant for Blackburn Mine	25,000

Aqueduct.	
54" steel main 7-16" thick, from McGregor to service reservoir—78,500 lin. ft.	1,448,325
Small stream crossings	9,500
Bridge on Gatineau River	130,000
Service Reservoir and Mains.	
Service Reservoir (as in 31 Mile Lake scheme)	260,210
51" steel mains to city (do)	1,101,120
Small stream crossing (do)	20,000
Bridge on Ottawa River(do)	180,000
Filters.	
Filtering Plant	500,000
Total for Works	$4,395,055
Add 15% for engineering and contingencies	659,258
	$5,054,313
Land and Lakes, compensation and wayleaves as per Mr. Gendron's estimate	2,000,000
Total Estimate	$7,054,313

CONCLUSIONS AS TO THE RELATIVE MERITS OF THE TWO SCHEMES.

In order more readily to compare the two schemes I have prepared a summary statement in parallel columns setting forth the main particulars of each scheme as laid out so as to give as a final result a water of equal purity. But, whereas, the Thirty-one Mile Lake and Pemachangaw drainage area would in all probability yield sufficient water to settle the water question for all time, it would be necessary if the population of the City increased above 500,000 persons to bring in some other source of supply to augment the McGregor Lakes.

	Thirty-one Mile Lake and Pemachangaw Lake.	McGregor Lakes.
(1.) Total quantity of water available.	81 millions gallons per diem.	51 million gallons per diem.
(2.) Quality of the water.	Bright and clear.	Somewhat turbid contains amorphous matter in suspension
(3). Filtration.	Not required.	Required.
(4.) Aqueduct.	235,000 ft. 54" pipe; 64,000 ft. 51" pipe.	78,500 ft. 54" pipe; 64,000 ft. 51" pipe.
(5.) Service reservoir.	To hold 295 million gallons.	To hold 295 million gallons.
(6.) Pressure (static.)	118 lbs. at Pumping station.	118 lbs. at Pumping station.
(7.) Estimated cost.	$7,985,200.	$7,054,313.
(8.) Working expenses.	$15,000 per annum.	$29,000 per annum.

FINAL RECOMMENDATION.

Reviewing all the circumstances of the case I have no hesitation in recommending the adoption of the Thirty-one Mile Lake scheme, in which I am glad to say Dr. Houston fully concurs.

It is as far as I know the purest source of supply in the world, and practically entirely free from any future contamination. This cannot be said of either the McGregor Lakes Suply or one derived from the Ottawa River both of which would require filtration, and the use of chemicals to render them safe and potable.

If the Thirty-one Mile Lake project is adopted, the City of Ottawa will have a supply for a very distant period in the future, which cannot be said of McGregor Lakes.

As to cost, Thirty-one Mile Lake gives 81,000,000 gallons, costing $8,000,000, whilst McGregor Lakes give 51,000,000 gallons costing $7,054,000. The annual working expenses for Thirty-one Mile Lake I estimate at $15,000, and the annual working expenses for McGregor Lake I estimate at $29,000.

ALEX. R. BINNIE.

No. 2.

REPORT OF DR. A. .C HOUSTON

UPON

GATINEAU LAKES SUPPLY.

This Report has been prepared and signed by Dr. Houston. It has been mailed, and as it is expected, will be received in a few days.

The Recommendations, and the reasons therefor, made in that report have been cabled, in order that they might be available at once. They are as follows:—

"I recommend the Thirty-one Mile Lake scheme in preference to the McGregor Lakes, because the former water is better on topographical, epidermiological, bacteriological, chemical. physical, and algae grounds.

"The Thirty-one Mile Lake source of supply is unimpeachable on public health grounds, and the water is of excellent quality, physically and chemically.

"The Thirty-one Mile Lake water would ensure to Ottawa immunity from water-borne epidermic diseases, for example, typhoid fever. The water is tasteless, odorless, and practically free from turbidity. It is almost colorless, and very soft.

"The Thirty-one Mile Lake water being physically satisfactory and free from human pollution, requires no filtration or other purification process.

"I have read and agree with the recommendations of Sir Alexander R. Binnie.

"I am totally opposed to the Ottawa River as a source of supply.

"Full report follows by mail."

A. C. HOUSTON.

Some little time ago when the estimates for the Thirty-one Mile Lake scheme and for the McGregor Lakes were being prepared Dr. Houston also sent the following cable:—

"Filtration of the McGregor Lakes may not be absolutely necessary but in view of possible algae trouble and undesirable pollution, I advise the inclusion of the cost of filtration in the estimates."

A. C. HOUSTON.

No. 3

Hull, P. Q., Sept. 24th, 1913.

J. A. Ellis, Esq.,
Mayor of Ottawa.

Dear Sir:—

I have gone carefully into the question of the value of the lands and Lakes which the City of Ottawa desires to acquire in the watershed of Thirty One Mile and Penichango Lakes. I have gone over the right of way for the pipe line from Long Lake to the City of Hull. I have examined the site of the proposed reservoir at Chelsea.

I estimate that the City of Ottawa will have to pay for the above Lakes, land, right of way, and site of reservoir $500,000.00. This includes my estimate of damage which may be done to Timber limits.

I have also considered the same matters in connection with the McGregor Lake watershed. My valuation, upon the same basis as for Thirty One Mile Lake and Penichango, is $2,000,000.

The reason why the latter valuation is so much greater than the first is because in the McGregor Lake watershed nearly all the land is patented, and a large proportion of it is cleared. This is not the case with regard to Thirty One Mile and Penichango watershed.

F. A. GENDRON.

No. 4

September 2nd, 1913.

Dear Mr. Borden:—

You will remember that on February 26th last I waited upon you with the Ottawa City Council to request that the Dominion Government would give some assistance to the City in the event of its undertaking to obtain a supply of pure water from the Gatineau Lakes. You were good enough to promise favorable consideration when the matter was further advanced.

I now enclose a memo herewith upon the subject. Also a memo re-Tariff duties on steel water pipes.

I would respectfully ask that it be now determined exactly what assistance the Government will recommend should be given to the City, so that I can lay this before the City Council with the reports of Sir Alexander R. Binnie, and Dr. Houston.

The carrying out of the project means the assurance to the City of Ottawa and the Dominion Government Buildings at Ottawa of an absolutely pure supply of water, without any filtration whatever, from a source which is sufficient for all future requirements.

It will also greatly increase fire protection for all buildings in Ottawa including those of the Government. The large expense involved, which it is anticipated will be between seven and eight-million dollars, is almost greater than the City can bear alone. Upon this ground, and because the Government will also get the benefits accruing from the proposed new supply of water, I respectfully ask that the City's request be favorably entertained.

It is particularly desired that a definite answer be given this month.

(Sgd.) J. A. ELLIS,
Mayor.

MEMO.

Re-Ottawa Water Supply.

(Referred to in letter of 2nd. September, 1913 from Mayor Ellis to Right Hon. R. L. Borden.)

Sir Alexander R. Binnie and Dr. A. C. Houston have recommended that the Ottawa River water is polluted, and cannnot be used without chemical treatment, and that it is advisable to go to the greater northern Gatineau Lakes where an absolutely pure supply of water can be obtained.

This project would result in a permanent supply of pure water being secured, but the expense for some years to come would almost be prohibitive for a city the size of Ottawa.

Since Sir Alexander R. Binnie and Dr. Houston reported as above in February last, surveys have been made and data secured of all the Gatineau Lakes. A report is now being prepared by Sir Alexander R. Binnie, and it is expected that such report will recommend Lakes Penichango and Thirty One Mile as the source of supply. It is anticipated that the cost will be between seven and eight million dollars.

This includes customs dues of 20% on steel pipe imported from Great Britain. Interest and Sinking Fund will be close upon $400,000 per annum, which will be the annual cost to the City of Ottawa if no assistance is given.

The Dominion Government pays $100,000 per year to the Ottawa Improvement Commission and $15,000 per year to the City direct. The latter amount is for the fire protection provided by the City to the Government Buildings.

The City provides the Government buildings with water and also supplies all the water required for watering the grounds connected with the Government Buildings. The City also waters the streets opposite to the Government Buildings, and cleans the snow from them.

Three years ago when the new agreement was entered into between the City and the Government it was estimated that the value of water supplied to the Government Buildings and grounds was about $80,000 per year. It is now about $100,000. In the same agreement it was also provided that Civic Service incomes should be exempt from taxation. This at the time amounted to $35,000 and it now amounts to about $45,000 per year. The value to-day of all these Civic Services to the Dominion Government is about as follows:—

$100,000 for water supplied,
45,000 for exemption of Civil Service Incomes,
15,000 for fire protection,
5,000 for Street Watering and Snow Cleaning.
Total, $165,000.

It is suggested that the Government increase the amount which they indirectly pay for water in the same proportion in which the annual charges of the City of Ottawa for water would have to be increased if the Upper Gatineau Lake Project is adopted. In this event it is necessary that the increased amount paid by the Government to the City for water should be paid directly to the Water Works Department.

The annual amount now collected for water rates in the City of Ottawa is about $320,000. If the Government was an ordinary water consumer it is estimated that they would have to contribute about 25% of the revenue required.

It is therefore suggested that the Government should pay an increased amount direct to the City of $100,000 per annum, if the project of securing water from Lakes Panichangou and Thirty One Mile is adopted.

The preferable way of making a cash contribution would be a direct annual cash payment, but the following methods of contributing are also suggested:—

1. Guarantee the City's Bonds. This would enable the City to issue its bonds at 4% instead of 4½% which would reduce the City's annual charges by about $40,000 a year.

2. Place the steel pipe required for the project on the "Free List." It is estimated that the steel pipe required will cost at the factory in Great Britain about $2,500,000. The pipe required is not manufactured in Canada and very little is manufactured in the United States. It is almost certain that the pipe would have to come from Great Britain. The Duty on such pipes is 20%, whcih means about $500,000. The interest and sinking fund on this amount is about $25,000 per annum.

The $15,000 now paid direct by the Government for fire protection to the City can be taken into account in determining the assistance to be given to the City in connection with its Gatineau Lakes water project.

In addition to this project giving the City and all the Government Buildings an absolutely pure supply of water, it would also afford a much larger protection against fire than at present. The Underwriters say that a gravity supply of water with a Service Reservoir such as is proposed, would give the form of fire protection which in their opinion is to be rated the highest. They also say that upon the installation of such a system they will reduce insurance rates in the City of Ottawa.

There can be no question that the protection against fire for the Government Buildings will be vastly improved over what it is at present by the installation of a gravity supply of water such as is proposed, and that these buildings would then have the greatest protection possible to be given them in case of fire. The Government is now at considerable expense in raising water to the top storeys of Government Buildings. The Gravity supply proposed would render this expenditure unnecessary. The supply will give a pressure of eighty pounds on Parliament Hill.

It is expected that the final report of Sir Alexander R. Binnie will be ready by October 1st. It is earnestly desired that a definite answer as to what assistance the Government can give should be furnished at the same time, as this will no doubt have a very large bearing upon whether the City of Ottawa adopts the proposition or not.

Ottawa, Ont., September 30th, '13.

Dear Mr. Mayor:—

Your letter of the 2nd. inst., with accompanying Memoranda has received the consideration of the Government and I am much pleased in conveying to you our conclusions as follows:—

The suggestion that the City's bonds should be guaranteed by the Federal Government could not be entertained. The same reply must be made to your suggestion that the duties should be remitted on the water pipe required for the projected line.

Your third proposal involves a substantial increase by the Federal Government of the amount which is at present paid to the City for fire protection. The City bases this proposal upon the ground that the fire protection afforded by the proposed service will be much more efficient than that which is now available. It is further based upon the assumption that the Federal Government should pay a reasonable proportion of the increased cost which will be entailed by the very expensive works proposed for the purpose of securing an abundant supply of absolutely pure water. As we understand it the cost will be in the neighborhood of eight millions dollars and the annual charge on the City for interest and sinking fund will be approximately four hundred thousand dollars per annum. It is urged upon behalf of the City that the abundant supply of pure water thus afforded is of great importance to the Federal Government, having regard to the large number of Civil Service employees resident in Ottawa, the gathering in Ottawa during several Months of the year of Members of Parliament, sessional and temporary employees of the Government and the large number of persons who find it necessary to visit Ottawa during the year for purposes connected with the various Departments of the Government. You have also pointed out that the efficiency of the fire protection will be greatly increased and that certain expenditure now necessary, under the present arrangement for water supply, will not be required after the new service shall have been put into operation.

After careful consideration of the reasons and grounds set forth in your Memorandum we are prepared subject to the approval of His Royal Highness the Governor General to recommend to Parliament the proposed increase in the annual payment.

Under the provisions of Chapter 45, Section 4, of the Acts 1909-10, Edward VII, the Government is authorized to pay to the City of Ottawa as a contribution to the maintenance of a fire protection service the sum of fifteen thousand dollars annually for a period of ten years from the first day of July 1909. The Government is prepared to introduce legislation for the purpose of increasing this annual contribution to the sum of one hundred thousand dollars per annum for water service and fire protection and to extend the period of ten years to fifty years, which, as we understand, is to be the term of the bonds proposed to issue. This annual payment or contribution shall be subject to the following conditions and understandings.

1st. That salaries and pensions paid out of the Federal Treasury to Civil Servants and others as well as the Sessional indemnity of Members of Parliament shall not be subject to Municipal Taxation of any kind or description by the City of Ottawa.

2nd. That no claim shall be made against the Government in respect of the watering of the streets, the removal of snow or other municipal services of a similar character.

3rd. That the proposed water supply both in quantity and quality is of the character and approximately of the cost set forth in your memorandum and that the source of supply is recommended and approved by competent experts whose opinion commends itself to the Government.

The present arrangements under which an annual grant is made for the purposes of the Ottawa Improvement Commission will be unaffected by the proposals which are above outlined.

J. A. Ellis, Esq., M. P. P.,
Mayor.

R. L. BORDEN.

N 5.

Ottawa, 18th, September, 1913.

J. A. Ellis, Esq.,
Mayor.

Dear Sir:—

In reply to yours of the 5th inst., I enclose statement of the annual cost of pumping and treating water from the Ottawa River; also cost of supplying water from wells for drinking purposes.

I may say the figures, wherever possible, are based upon the cost to-day; that year by year they will naturally increase just as they have done heretofore.

I would particularly call your attention to the fact that only ordinary current expenses are dealt with.

W. H. CLUFF,
Auditor.

ANNUAL EXPENSES IN CONNECTION WITH THE SUPPLY OF WATER FROM THE OTTAWA; NOT TAKING INTO ACCOUNT CAPITAL EXPENDITURE OR INTEREST AND SINKING FUND.

Pump House Salaries	$ 8,280 00
Pump House Extra Help (Average Fortnightly $100.00)	2,600 00
Pump House Machinery Repairs Estimate	5,000 00
Pump House, Light , Fuel, Oil, Packing	1,500 00
HINTONBURG:—	
Pump House (Steam) Wages	4,446 00
" Light, Fuel, Oil, Packing	3,000 00
" Machinery Repairs	1,000 00
OTTAWA EAST:—	
Pump House Wages	720 00
" Power	200 00
" Incidentals	300 00
BOOSTER STATION:—	
Power	1,400 00
Maintenance	3,000 00
HYPO PLANTS:—	
Wages ($171.50 per 2 Weeks.)	4,459 00
Cost of Hypo	4,000 00
Incidentals	2,000 00
LEMIEUX ISLAND PUMPING STATION:—	
Wages	4,004 00
Power	3,375 00
Incidentals	1,500 00
AQUEDUCT:—	
Maintenance	5,000 00

DISTRIBUTION OF WELL WATER:—	
Ottawa Dairy Company	9,000 00
Wages ($150.00 for 2 Weeks.)	3,900 00
	$68,684 00

No. 6.

Ottawa, Canada, September 25th, 1913.

His Worship Mayor Ellis,

ADDITIONAL PUMPING PLANT.

Dear Mr. Mayor:—

With reference to your letter of the 5th. instant, I have pleasure in submitting the following report as to the additions required to the present Pumping Plant to bring it up to the capacity of the First instalment of what the project to be recommended by Sir Alex. Binnie, will deliver in Ottawa.

The estimated capital cost is as follows:—

Installing 2 Units	$55,000 00
Installing 2 Turbines	9,000 00
Extension of Pump House	15,000 00
Diverting the present Overflow	2,000 00
	$81,000 00
Add 10% for Contingencies	8,100 00
Total	$89,100 00
Say	90,000 00
Annual Maintenance Charges for additional Units	3,200 00

The calculated theoretical capacity of the present pumping Plant is 35,000,000 gallons per diem, but the practical delivery allowing for slip, and maintaining a domestic pressure of 90 lbs., the pumps cannot be relied upon to do more than 27,000,000 gallons per diem.

Assuming a working pressure of 110 lbs. in order to compare with the project to be recommended by Sir Alex Binnie, the present plant can only be calculated to give a delivery of 25,000,000 gallons, therefore the present plant should be increased by the new units, each of a capacity of 5,000,000 gallons per diem. These two additional units are all that could be safely carried by the water from the Aqueduct.

To enable this power to be used, would require an extension of the present Pumping House on the east side. The present overflow from the Aqueduct would have to be diverted, passing under the bridge and discharging into the present tail-race some yards lower than at present.

By having two additional Units would enable one of the present ones being kept as a spare. Should any of the units break down it would mean stopping the pumps and lessen the delivery of water into the City mains by at least 10,000,000 gals. per diem.

It has to be pointed out that the estimate given does not include any figure for renewal and replacing any of the present plant, a condition of affairs which is certain to arise in a few years time.

ARCH. CURRIE,
City Engineer.

Ottawa, 27th September, 1913.

J. A. Ellis, Esq.,
Mayor.

Dear Sir:—

I have yours of 26th. enclosing estimate of City Engineer Currie, of the cost of additional equipment at Pump House to provide a service equal to the estimated service, that will be provided by the proposed "Gatineau" supply.

Assuming Mr. Currie's estimate to be correct, the annual cost for Interest and Sinking Fund for a capital charge of $90,000.00—30 year debenture at 4½% will be.. $5,940 00

Annual charge for maintenance of units..................... $3,200 00

This is all the data contained in Mr. Currie's estimate; but in my opinion there should be an allowance for extra assistance in Pump House of $2,000 00

$11,140 00

W. H. CLUFF,
Auditor.

No. 7.

CANADIAN FIRE UNDERWRITERS' ASSOCIATION.

Toronto, Sept. 24th, 1913.

J. A. Ellis, Esq.,
Mayor,
Ottawa, Ont.

Dear Sir:—

Referring to your communication of yesterday and our conversations previously, I have now pleasure in advising that a general reduction in insurance rates would be made in your city as soon as such a scheme for water supply as you have outlined is carried out. My understanding of this scheme is that a gravity system is to put be in, the primary source of the water supply being the Gatineau Lakes, and these to feed a reservoir at Chelsea which will always contain ten days supply of water and will be at such an elevation as will give a pressure at the hydrants of eighty pounds at the corner of Sparks and Melcalfe Streets, while fire streams of the standard number and size are being used.

Subject to the provision of duplicate supply mains of adequate size to connect the reservoir with the city, and a good system of distribution in the city itself, with, of course, the maintenance of a sufficient brigade and apparatus such a scheme as is proposed would for fire purposes be best obtainable, and the Underwriters would be very glad to see your city so equipped and to give you the fullest possible recognition in the way of improved rates.

JOHN A. ROBERTSON,
Secretary.

No. 8.

Ottawa, September 16th, 1913.

I beg to submit herewith the information you asked for yesterday, with regard to the working pressure it will be possible to maintain on Parliameent Hill with the proposed Gatineau gravity system in operation, and under the most severe conditions, such as would be imposed by a fire draft to handle a conflagration in this vicinity:—

The calculations are based on the following data:

	Elevation City Base.
High Water level service reservoir..............	327.5
Mean " " "	322.5
Highest point Wellington St. 200 ft. west of Elgin Street	139.5
Parliament Hill at foot of steps to terrace in front of main buildings......................	150.5
Parliament Hill at top of steps to terrace in front of main building.....................	160.3
Parliament Hill immediately in front of entrance to main building..........................	165.3

The service reservoir is 6 miles from the Pumping Station.

It is proposed to lay 2 lines of either 42″ or 48″ steel pipe from the service reservoir to the City.

The static pressure at the highest point on Wellington Street with the reservoir at mean level is 183 ft., that is approximately 80 lbs. per sq. inch.

The static pressure at the foot of the steps to the terrace in front of the Main Building is 172 ft. that is approximately 75 lbs. per square inch.

I have assumed that the Gravity lines will be connected to Bronson Avenue by such sizes of pipes as will give practically the same pressure on the street mains from Wellington to Slater Streets inclusive, running west from Bronson Avenue.

I have further assumed that by the time the gravity system is in operation the population of the City will total 120,000, and that by that time the average water consumption will have been reduced to at least 100 gallons per capita per day.

A conflagration in the section around Sparks and Metcalfe streets might require from 25 to 30 streams. I have taken 28 streams of standard capacity and these represent a draft at a rate of 2,400,000 gallons per day.

I have considered this draft carried from Bronson Avenue by the mains on Wellington to Slater Streets inclusive. These pipes will also have to carry a portion of the total domestic draft; for purposes of calculation I have assumed that the domestic draft will be carried by these pipes for that section of the City bounded by Bronson Avenue, Laurier Avenue, the Canal and the River; and for the whole section lying east of the Canal and north of Laurier Avenue. These two sections comprise about 30% of the total City area, and I have assumed that the domestic consumption in them will approximate 30% of the total domestic consumption.

The contingency of a bad fire occurring or continuing at the time of the maximum domestic rate, must be taken into consideration, and I have therefore counted on a domestic rate of 120 gallons per head per day, or total domestic draft at a rate of 14,400,000 gallons per day.

Therefore the total loss of head for the case in question will be the friction loss in the gravity lines when discharging at a rate of 22,500,000 gals. per day, i. e. (14,400,000 plus 8,400,000) and the loss in the street mains on Wellington to Slater Streets inclusive from Bronson Avenue to the section immediately around Melcalfe and Elgin, when carrying 12,700,000 gals. per day i . e. (8,400,000—14,400,000 x. 3.)

I estimate the loss in new gravity lines as follows:—

GRAVITY LINES		LOSS OF HEAD IN	
Size.	Class	Feet.	lbs. per sq.in.
48″	Welded	7.0	3.0
48″	Riveted	8.5	3.7
42″	Welded	13.5	5.9
42″	Riveted	16.5	7.2

The present mains from Bronson to Melcalfe on the streets from Wellington to Slater inclusive are for the most part 5″, 12″, 15″ and the recently constructed 24″ main. Some of these are continuous, others are incomplete lines, being apparently installed with the intention of future extension. I haven't had time to work out the best scheme for reinforcing this section, but it is obvious, that with a heavy fire draft immediately around Metcalfe and Sparks Street additional feeders are needed from the 15″ and 24″ on Slater Street to the point of concentration. At the very least a new 12″ main should be laid on Bank Street from Slater to Queen and a 16″ on Metcalfe St.from Slater to Queen.

If the present pipes are as well preserved as they are alleged to be, and so interconnected as to make the best use of them, and if new pipes as specified above are laid on Bank, and Metcalfe Streets, I estimate that the loss of head from Bronson to the vicinity of Metcalfe and Sparks Streets, under the conditions already referred to, will be about 17 ft., i. e. 7.4 lbs. per square inch. The cost of installing the new mains exclusive of any other improvements to the existing system would be about $4,500,000.

I have already remarked that the existing street piping from Wellington to Slater was not well balanced, due to the fact that a number of mains are not extended through this section, and as a consequence there are several examples of branches and mains many times larger than their feeders. To complete this section of the distribution system on the scheme apparently originally intended, the additional mains required on east and west streets would be as follows:—

2,500 ft. 15″ on Wellington from Bronson to Bank,
1,700 ft. 12″ on Sparks from Bay to Bank,
800 ft. 12″ on Queen from Bronson to Bay,
3,000 ft. 15″ on Albert from Lyon to Elgin,
250 ft. 15″ on Lyon from Slater to Albert.

With these new east and west mains in service in addition to the cross connections, the loss in head from Bronson to Metcalfe would be reduced from 17ft. to 8ft., i. e., 3.5 lbs. per square inch.

I estimate the cost of the east and west mains as per the above schedule, including repairs to permanent pavements, at from $40,000.00 to $45,000.00.

So far as the requirements of this high level section for its own fire and domestic service are concerned, it would not be necessary to install additional mains except on a few of the cross streets and on the east and west streets where the present pipes are 5″ or under. The capacity which will be found necessary for feeders to the section east of the Canal, will largely determine to what extent it may be found advisable to adopt this scheme of additional east and west mains, or its equivalent through the high level section.

In advance of a definite proposal with respect to the size of the gravity lines, and the reinforcement of the distribution system from Bronson Avenue to Elgin Street, all that can now be said is, that under the heaviest anticipated draft, the maximum loss of head from the service reservoir to Parliament Hill is not expected to exceed 35 ft.will not be less than 15 ft., and as a reasonably close prediction may be taken at about 10 lbs. per square inch, i. e., from 20 to 25 feet.

Accepting the latter, the pressure on Parliament Hill at the base of the steps to the terrace in front of the main building, will be about 65 lbs. per square inch, with the maximum fire draft from the nearest hydrants—and at the highest point on Wellington Street, the pressure under these circumstances will be about 75 lbs. per square inch.

The loss of head and the pressure previously stated, refer to hydrants or any other connections from which water is not being drawn—there will be a loss of head pressure in the hydrant and its connection to the main of about 2 lbs, and more depending on the size and type.

May I remark that the practice of expressing the service that will be available from the Gatineau scheme in the terms of the pressure at some high point in the Parliament grounds, remote from the distribution system is hardly reasonable or fair to the scheme. In the first place there is only an 8″ pipe in the Parliament Grounds and one or two hydrants, so that it is possible to use only a few streams there. Moreover even with the closest hydrant spacing 25 or 30 streams must necessarily be distributed over an area of one-half of a mile or more in circumference.

Probably no two hydrants in use would show the same running pressure, but obviously the average pressure of all the hydrants is a fairer measure of the fire service, than the pressure of the most unfavorably situated hydrant.

In line with these arguments, I believe it can be said that with a draft of 25 to 30 standard streams, the average working pressure at the hydrants in the highest area will be about 80 lbs. per square inch.

This pressure is really referred to the Corner of Sparks and Metcalfe Streets which would be centrally located with respect to the hydrants that would impose the hardest test.

In conclusion I wish to point out that minor losses of head usually neglected as inappreciable in comparison with the total loss may in this case. since the frictional losses are of such a very low order, amount to a considerable percentage of the estimated loss, and correspondingly affect the predicted results.

ARCH. CURRIE,
City Engineer.
W. S. LEA,
Consulting Engineer.

NO. 9.

CITY ENGINEER'S OFFICE.

Ottawa, Canada, Oct., 3rd, 1913.

His Worship,
Mayor Ellis,

Water Supply from Ottawa River.

Dear Mr. Mayor:—

As requested in your letter of 23rd June, 1913, requesting that if the City of Ottawa continues to use the Ottawa River water in its natural condition as a permanent source of supply, what would be the best point from which the water should be taken, what works would require to be constructed with an estimate of the expense of such works, the following report is submitted:—

Having in view that this report deals entirely with the question of using the Ottawa River water in its natural condition, the position of the intake Pipe has to be regulated in order to avoid as far as possible, polluted water. Taking the south shore of the Ottawa River, the nearest point where there would seem to be the least pollution would be at Beeties' Point about 2½ miles west of Britannia. This point is not all that could be desired as it is somewhat east of the village of Aylmer on the north shore of Lake Deschenes, and liable to pollution from that village, also being immediately east of Shirley Bay, makes this site not at all favorable. This position of the Intake Pipe would be about 10 miles from the Main Pumping Station in Ottawa.

A much better point for the Intake is considered to be slightly west of Ennis' Point or opposite Aylmer Island. This point is west of the village of Aylmer and consequently free from any pollution from the village, but it has to be remembered there will always be more or less pollution from the villages or residences on Lake Deschenes. This latter point is about 14.8 miles from the Main Pumping Station and as it appears to have greater advantages than Beetie's Point, the estimates, &c, are framed on taking water at this point.

After leaving the Intake, the pipe line will run almost parallel to the shore of Lake Deschenes for about 3.8 miles till it joins the South March Road, running on this road till the C. P. R. main line is crossed, then running parallel to the C. P. R. till the Richmond Road Crossing is reached, afterwards keeping on the Richmond Road and Wellington Street to River Street, going south of River Street to Spencer Street, running East on Spencer Street to Parkdale Avenue to Scott Street, delivering into a low level service reservoir.

From this reservoir the pipe line will run along Scott St. through the C. P. R. yards to Broad Street then alongside the Aqueduct to the Main Pumping Station.

From levels taken it is quite apparent that a gravity line is out of the question.

It will be necessary to install a motor driven pumping plant at the Intake in Lake Deschenes discharging through a pipe line to a low level reservoir in the City with gravity lines from the reservoir to the Main Pumping Station.

It is assumed that the waste of water will be restricted to such an extent that by the time supply could be in service or shortly afterwards, the average domestic consumption will be reduced to about 100 gallons per capita per diem. With an average consumption of this order, there will of course be certain days during which the consumption will exceed this rate by probably 30 or 40 per cent, and provision will have to be made in the two Pumping plants, viz·

at Lake Deschenes and the Main Pumping Station, and in the pipe lines to take care of the fluctuation in the domestic consumption as well as the occasional demand for fire service.

With a reservoir in the City of sufficient capacity to provide for the maximum fire draft and for variations in domestic consumption it is obvious that the capacity of the pumping plant at the Main Station and the pipe lines from the reservoir to the Main Station should be capable of supplying water at a rate which is equal to the macimum fire draft plus a domestic draft of 20% in excess of the average, viz:—120 gallons per capita per diem.

The capacity of the reservoir should be based on a supply capable of maintaining the maximum fire draft and a domestic draft of 20% in excess of the average for nine hours when two thirds full.

The capacity of the Pumps at Lake Deschenes and the pipe lines from the Lake to the reservoir, should obviously be equal to the maximum daily domestic draft, that is to a rate of about 40 per cent in excess of the average.

Adopting estimates which have been prepared in connection with other reports of the anticipated increase in the population of the City of Ottawa which have been based on the growth prevailing for the past ten years, the requirements for domestic and fire services, would approximate the quantities scheduled in the following table:—

TABLE No. 1.

Year.	Rate of Draft in million gallons per diem.					
	Estimated population.	For Domestic Service.			For Fire Service.	For combined Fire and Domestic service.
		Yearly av.	Max. days.	During fires.		
1920......	120,000	12	16.8	14.4	8.5	22.9
1930......	170,000	17	23.8	20.4	10.0	30.4
1940......	230,000	23	32.2	27.6	11.0	38.6
1945......	250,000	25	35	30	12.0	42.0

The a-pproximate capacities of the two Pumping plants and the pipe lines on the basis already referred to would be according to the following table:

TABLE No. 2.

Capacities in million gallons per diem.

Year.	Pumps at the Lake exclusive of reserves and pipe lines from Lake to reservoir.	Pumps at Main Station exclusive of reserves and pipe line from reservoir to Main Pumping Station
1920.......	16.8	22.9
1930.......	23.8	30.4
1940.......	32.2	38.6
1945 (say)..	35.0	42.0

Pumps at Intake.

It is proposed in the initial installation to erect four 9,000,000 gallons motor driven Turbine Pumps capable of a maximum over all lift of 85 ft. The total installation commensurate with an average daily consumption of 25,000,000 gallons will consist of six 9,000,000 gallon units. This installation will provide for Two Units in reserve over and above the maximum daily draft which has been estimated at 35,000,000 gallons. It is essential for safety that the transmission lines, from the City to the Pumps at the Intake, should be in duplicate, and from separate Power Stations. The situation can easily be imagined in the event of a fire in the City and possible break or interruption in the transmission lines just at the moment power was required, a duplicate line will minimize this risk.

The elevation of the ground at the site selected for the reservoir is about 82. On the basis of the storage requirements already referred to, a reservoir of about 10,000,000 gallons capacity should be provided with an effective depth of about 16 ft., the flow line being at elevation 87, and bottom at elevation 71. The gravity lines from this reservoir to the main pumping station with the pipes laid at a reasonable depth will have a total fall of 24 ft.

The main Intake will be a 60″ diameter steel pipeextending a distance of about 2,000 ft. into Lake Deschenes terminating in apier provided with screens and head gate and laid in a trench to a suction well under the pumping station. A shorter Intake pipe 48″ diameter for emergency purposes will also connect to the suction well.

By referring to Table No. 1, it will be noted that the necessary capacity for the pipes during the first 10 or 15 years of their service is about 30,000,000 gallons per diem.

Estimates of other schemes which have been prepared, have generally been referred to an average domestic consumption of 25,000,000 gallons per diem, and for purposes of comparison therewith, I have carried the tabulated estimates of capacity to such times in the future as it might reasonably be expected the average consumption will amount to this.

I believe that this rate will be approximately within the life of any work immediately constructed.

Under ordinary circumstances the interest and depreciation on the cost of an installation providing for capacities which would not appear necessary until 25 or 30 years later would probably exceed the cost of another installation put in when the demand necessitated it. In the case in question, however, we are obliged for reasons of safety to provide duplicate pipe lines. The route for these pipes from the reservoir to the Main Pumping Station will be along the south side of the Aqueduct and though the C. P. R. Yards, and I do not think it advisable to install pipes of a capacity which need to be supplemented within 15 or 20 years. I estimate that 2-42″ lines will eventually be required from the reservoir to the Main Pumping Station.

With respect to the lines from the Lake to the Pumping Station as the route is in part through the Ottawa Electric Company's right-of-way, in part through private lands, near the Lake, and for the greater part on the public road, the objections mentioned in connection with the gravity lines apply to a lesser degree.

There is another point for consideration in connection with the force mains from the Lake to the reservoir, namely, that as it is economical and convenient to use motor driven turbine pumps, it is desirable to keep the total life under which pumps are to run as low and as uniform as possible.

Obviously when the lines are first put in service, being then in their best condition and carrying a relatively small quantity of water, the pumps must necessarily operate against a lower head than they will afterwards be subject to.

It is proposed to overcome this difficulty by adopting speed motors or pumps designed especially with uniform power characteristics. Moreover the larger the pipe the smaller the loss of head at any time and consequently the power charges will be considerably less.

I have compared two or three propositions involving pipe lines of different sizes from the Lake to the Reservoir, and the choice would appear to rest between 2-48" lines and 2-42" lines.

The cost of the whole installation consisting of Pumps, transmission lines and pipe lines, would be about $200,000 less for the 42" lines if they are adopted The power required, however, would on the average be about 500 h. p. more with the 42" lines than with the 48" lines. 500 h.p. at $20.00 (See Table 3 below) amounts to an anual charge of $10,000 per year which will be noted is just 5% on the extra cost of the 48" lines:—

TABLE No. 3.

Electrical H. P.	Reg'd normal load av. days pumping.	Metered in City peak load max. days, pumping.	Emergency load on demand in the event of a break in one pipe line.
Initial installation......	300	450	525
Final installation (1945)..	500	1000	1225

Obviously on the bais of an annual charge there is very little difference between the two, but as the 48" would at all times be working under a lower head, and as the power which will have to be available on demand in caseof an accident to one of the lines, will be much less with the 48". I believe the larger size is to be perferred.

It is proposed in all of these lines to cross connect them at close intervals providing valves on the cross connections and on each side of the junction on both sides. In case of a break in any line this section can be isolated and in this way the increase in the loss of head for the same carring capacity will be kept within the limits that can safely be handled by the pumps, motors and transmission equipments.

It is proposed to cross connect the force mains from Lake Deschenes every 8,000 ft. and the gravity lines from the reservoir to the Main Pumping Station will be cross connected at 3 points, dividing the line into four 1700 ft. sections. With one section out of commission, the capacity of the 2-42" mains from the reservoir to the Main Pumping Station will be from 40 to 45,000,000 gallons per diem. With one section out of commission the capacity of the 2-48" lines from the Lake to the Reservoir will be 35,000,000 gallons per diem. with p umps at the Intake working at a total life of 85 ft. These capacities are based on the condition of the pipes after they have been in service 25 years or more, when their initial capacity will be considerably reduced by tuberculation.

The 10,000,000 gallon reservoir will have a dividing line across the centre so that one half of the reservoir may be emptied for purposes of repairs and inspection, and the 48" lines will be by-passed around the reservoir to connect with the 42" gravity lines, all controlled by suitable valves.

It is to be noted that the variations in domestic consumption with the pumps at Lake Deschenes running at the average daily domestic rate, will draw the reservoir between 3 and 4 ft. out in the course of a day, it is intended in the operation of this system, to keep this reservoir continually full, or nearly so. High and Low water alarms, and water level regulating valves will be installed for this purpose.

It might be asked why duplicate pipe lines and their accessories are adopted in connection with this report on the Lake Deschenes scheme.

By referring to the Canadian Underwriters Association requirements the following will be found:—

Article No. 25 reads:—

> "Where fire pumps are operated by electricity, the generators,
> "transmission lines, and other essential appurtenances should be strictly
> "in duplicate; and if otherwise, Standard steam pumps with sufficient
> "steam, or some other adequate and approved auxilliary power, should
> "be always immediately available."

Article 33 reads:—

> "Supply mains and conduits from source of supply to suction well
> "or pumps; from pumps and reservoir, and also from standpipes and
> "elevated tanks, to commencement of general distribution; are required
> "to be in duplicate."

The cost of duplicating the transmission lines is only about $30,000,00, and when we consider that one line may be put out of commission for several days, particularly by a fire in the City or an accident to the generating station and if this line were put out of service by such a contingency as falling buildings or burning poles, the City would be deprived of a water supply at the very time it needed it. The only condition on which one transmission line could be entertained would be an independent installation of steam, oil, or some other type of pumping plant at the Lake Deschenes Station in addition to the motor driven pumps. So far as the initial costs are concerned the additional transmission line is much the cheapest way to provide duplicate service.

With respect to the pipe lines from the reservoir to the Main Pumping Station, it is presumed that no one will question the necessity of duplicate lines in this element of the service as in a direct pressure system the main pumps must be run regular..

With respect to the force mains from Lake Deschenes to the City the necessity for duplicate lines is involved in the size of the service reservoir it is advisable to construct. I am of the opinion that if we had a reservoir in town capable of holding say four days supply, that is a reservoir having a capacity of from 80,000,000 to 100,000,000 gallons that it would be quite safe to depend on a single line from Lake Deschenes to the reservoir.

A 60 in. single line could be substituted for the 2-48" with practically the same pumping installation. I estimate that a single 60" line would cost about $800,000.00 less than the 2-48" lines. On the other hand, a reservoir holding from 80,000,000 to 100,000,000 gallons, including cost of a site at 10c per square foot would cost, with rock excavation $2,000,000.00

With regard to the justification for a large storage with a single pipe line or two pipe lines with a small storage, the most important consideration is in connection with possible fire loss and also with fire insurance rates. I feel perfectly sure that the additional cost of two pipe lines would be recovered many times over by the total saving in insurance premiums for the whole City, due to the lower rates which the Underwriters are sure to establish with a duplicate service in operation. Apart from this consideration there is the contingency of a conflagration getting under way at a time when the pipe line was out of commission and the loss in conflagrations of this kind which have occured in several other cities on this continent, would in itself pay for the whole Lake Deschenes scheme many times over. There is another consideration and that is convenience in operations. You are obliged to have valves at certainpoints along the line and as the pipe gets older it may be necessary to remove incrustations and repair the pipe and with only one pipe to rely upon it would always be a source of worry and inconvenience. Towns much smaller than Ottawa and with very low fire risks have gone to the expense of duplicate lines from the source of supply.

Of course a steel pipe line, if well laid and suitably protected against water ram should be pretty safe against failure. However, along the line of this route, at street crossings, railway crossings, etc, the necessity for building construction, and installation of sewers, gas mains, or water mains crossing the line of the pipe, with blasting incidental to such construction work, constitutes an element of danger in a route such as the Lake Deschenes which does not apply to a route through the country.

1. **Intakes & Suction Well.**		
1-6o" x ½" Steel Pipe, 2,000 ft. long with pier at outer end		
1-0 48" x ½" Steel Pipe, 800 ft. long with pier at outer end	$	75,000 00
1 Suction Well, say 15' x 25'		
2. **Pumping Station, Mens' Quarters, Foundations for machinery**		25,000 00
3. **2 Transmission Lines Step Down Transformers, and all electrical equipment exclusive of motors**		70,000 00
4. **Motor Driven Pumping Plant.**		
6-9,000,000 gals. per diem, Motor Driven Pumping Units erected		33,000 00
5. **Steel Pipe Lines from Intake Pumping Station to Reservoir.**		
2-48" dia. Steel Pipes, (3-8" & 5-6")		1,050,800 00
Laying Steel Pipes		170,400 00
8 Cross Connections, valves & valve chambers		25,000 00
6. **Excavation, backfilling & removal of surplus material**		620,000 00
7. **10,000,000 Gallon Covered Reservoir.**		
Two compartments 5,000,000 gals. each		225,000 00
8. **Steel Pipe Lines from Reservoir to Main Pumping Station.**		
2-42" dia. Steel Pipes x 3-8" thick		93,160 00
Laying Steel Pipes		15,070 00
3 Cross connections, valves & valve chambers		10,000 00
9. **Excavation, backfilling and removal of surplus material**		73,500 00
10. **Reservoir Site**		12,500 00

Rights-of-way and site for Pumping Station at Lake Deschenes	7,500 00
Total	$ 2,505,930 00
Add 15% for Contingencies & Supervision	375,889 00
	$ 2,881,819 00
Say	$ 2,900,000 00

ANNUAL CHARGE FOR OPERATION OF PUMPS AND MAINTENANCE.

Power	$ 9,000 00
Wages	9,000 00
Stores and Minor repairs	500 00
Heating	1,500 00
	$20,000 00

ARCH. CURRIE,
City Engineer.

No. 10.

ONTARIO PROVINCIAL BOARD OF HEALTH.

Toronto. April 7th, 1913.

Re Water Supply for City of Ottawa.

My dear Mr. Ellis,

In reply to yours of the 4th inst. I beg to say that the Provincial Board of Health has detailed information respecting the character of the water of the Ottawa River and of Lake Deschenes. These waters are so badly polluted that the Board will not allow of their use without filtration. The fact very generally known throughout the country that Ottawa had about 3,000 cases of Typhoid within a year and a half from using this water should be quite sufficient answer to any one making such a proposal.

I shall attend the meeting of the Committee Tuesday morning and if you think it desirable I should be glad to give the Committee further information.

J. W. S. McCULLOUGH,
Chief Officer of Health.

No. 11.

CITY TREASURER'S OFFICE,

October 4th, 1913.

J. A. ELLIS,
Mayor.

Dear Sir:—

In compliance with your letter of the 3rd inst, I calculate Sinking Fund at 4% and for interest 4½%.

Debentures issued under the Legislative Act of this year to be:—

50 years on $8,000,000	$412,401 60
50 years on $7,000,000	$360,851 40

Debentures issued under General Law Sinking Fund at 3% and interest at 4½%.

30 years on $2,900,000	$191,455 80
30 years on $1,100,000	$ 72,621 20

L. H. CORBETT,
City Treasurer.

No. 12.

J. A. Ellis, Esq., M. P. P.

Paris, Sept. 17th, 1913.

Mayor Ellis,
City Hall, Ottawa, Out.

Société Canadienne Ozone offers to the City of Ottawa to construct for its own account complete installation for filtration and sterilization of its Ottawa water, producing twenty five million gallons water daily perfectly pure, filtered and steril—for periods of thirty years in exchange for percentage of price paid per thousand gallons by inhabitants.—After thirty years entire plant becomes property City of Ottawa. The water can be taken direct from the river, useless to fetch it from Lake Gatineau. We recommend City Engineer Archibald Currie come here see our numerous modern installations; our head Engineer will return with him to Ottawa with full plans. Could complete entire construction one year to fifteen months. Kindly cable price paid by inhabitants for thousand gallons delivered and say if our proposition in principle meets with your approval.

BEHRENS, ENOZO,
Paris.

Ottawa, 19th. Septr. 1913.

Behrens, Enozo,
Société Canadienne Oxone,
Paris.

Inhabitants pay flat rate for water. No meter charges. On basis your offer what would you charge per annum for twenty-five million gallons water delivered daily.

ELLIS.

Paris, Sept. 20-13.

Mayor Ellis;
City Hall, Ottawa.

We must know approximately how much the City of Ottawa charges or receives for one thousand gallons. We will then be able to make our calculation and quote a price pretty correct for delivering you twenty five million gallons daily. We erecting entire plant at our expense operating same ourselves for thirty years when planth ecomes property City of Ottawa. Kindly cable.

BEHRENS.

Ottawa, 22nd September, 1913.

Behrens, Enoso,
Société Canadienne Ozone,
Paris.

City now using seventeen to eighteen million gallons per day. Total annual revenue for water now received by City about three hundred and sixty thousand dollars.

ELLIS.

No. 13

EXTRACT FROM REPORT OF MESSRS. HERING & FULLER OF NEW YORK TO CITY OF MONTREAL ON WATER SUPPLY, DATED 2nd JULY 1910.

OZONE TREATMENT.

Ozone is a modified form of oxygen and serves as a most powerful oxidizing agent for the destruction of organic matter, including living bacterial cells. It is found more or less in nature particularly after thunder storms, and is manufactured commercially through the use of electricity discharged through the atmosphere under very high voltage. It has been actively befor people as a prospective water purifying for some 15 years and has attracted widespread attention.

We have followed its developments closely from the beginning and have personally inspected its standing in Europe, particularly at Paris in 1900, 1905, 1906, 1908 and 1910.

Ten years ago this process was considered capable of sterilizing a water, which was substantially free from readily oxidizable organic matter, at a cost in the neighborhood of $5 to $6 per million Imperial gallons. There is no question as to the efficiency of ozone under suitable conditions indestroying bacterial life. There are some questions as to the degree of concentration of the ozone wheich must be present in the ozonized air which is to be mixed intimately with the water to be treated. The expense of the ozone treatment seems to increase materially with increases in the concentration of ozone in the ozonized air.

Marked progress has recently been made in perfecting ozonizers so as to render their performance cheaper and also much more reliable. Investigations as to the use of ozone were conducted at the Jerome Park reservoir in New York City in 1907-8, but the result was unsatisfactory, partly owing to the irregularity with which the orsonizers performed, and partly on account of the prohibitive expense of the treatment.

In Europe there has been comparatively little development on a working basis in the past decade. Plants in regular service on a commercial scale are practically confined to the small town of Paderborn in Westphalia. We have also seen a small plant in commercial operation at Breda, a small village in Holland. Another plant is at Weisbaden, Germany, where it is held in reserve, for the treatment in case of emergency, of water from certain wells near the Rhine which contains contaminated water and which are not used regularly.

While numerous investigations at certain places in Europe have been made with ozone, developments have been practically confined to the places above mentioned, and at St. Maur, one of the suburbs of Paris, where is located a sand filtration plant from which, after treatment with ozone, a portion of the city water supply is derived. The source of this water is the River Marne, a tributary of the Seine. For a dozen years or so, St. Maur has been the scene of almost uninterrupted investigations as to the utilization of ozone for the treatment of the Paris water supply. Its use is proposed in connection with what are called preliminary filters, or roughing filters of the Puech-Chabal type. These perliminary filters are intended to act simply as clarifying devices and it is the ozone which is relied upon to remove the bacteria.

A year ago it was decided to intall at St. Maur an ozonization plant with a capacity of 20 million Imperial gallons daily. Plans for the installation of this plant, with a division of the contract equally between the De Frise and Otto systems, have been approved by the Minister of the Interior and by the Superior Council of Public Hygiene, but they have not been ratified by the Municipal Council. That is to say, no contract has been closed for those ozone devices. At present the works at St. Maur are temporarily out of service owing to damages caused by the recent severe flood, but are under process of repair. It is understood that still further tests are to be made, or are being made now, at St. Maur, on the Gerard system of ozonization and that if this method or device proves satisfactory the 20 million gallon contract will be devided equally among the three companies instead of the two above mentioned.

The construction cost of ozonization at Paris, according to the different systems, runs from about $6,000 to $15,000 per million gallons daily capacity. The operating cost is estimated at about $6.00 to $7.00 per million gallons these figures being set forth in a report by Colmet-Daage, City Engineer of Paris.

There is no doubt about the Paris authorities being determined to get the best water obtainable from the local river water, as distinguished from further developments of distant gravity sources, and that there has been substantial progress made there as to the use of ozone as an adjunct to filtration.

Comparing the cost and reliability of ozone with the electrolytic decomposition of salt in order to obtain hypochlorite of soda, or upon comparing it with hypochlorite of lime, we see no justification whatever on the ground of cost, to say nothing of irregularity of performance, to recommend the ozone treatment at this stage of developments. We formally reported to that effect to the Water Commissioners at Niagara Falls, N. Y., last February. Mention is made of this fact as illustrating our conviction in this regard for a project where electric power is available in large quantities at prices which can scarcely be lower elsewhere.

In our investigations of the Montreal project we have taken occasion to visit with Mr. Janin the ozone plants at Lindsay, Ont., and Ann Harbor, Mich. We consider them to be interesting plants, showing that ozonizers can be built and operated with fewer interruptions than we are led to believe possible from our observations of the developments three years ago at Jerome

Park Reservoir, New York City. They are now being used at these towns above mentioned with filtration devices which are very crude and inexpensive At Lindsay, the Provincial Board of Health authorities of Ontario, under date of February 8, 1910, unqualified condemned the ozone plant as sterilizing process. They reported it to be unreliable and attributed substantially all of the success of the plant to the arrangements and devices other than the ozone. At Ann Harbour it is claimed that the bacterial results obtained are on a more satisfactory basis than at Lindsay, but official reports have not been made public. At both of these places the ozone gives no indication of having any practical efficiency in the removal of color or vegetable stain from the water. At Ann Arbor the final treated water had a noticeable amount of vegetable stain, notwithstanding that use is made of a slight quantity of sulphate of alumina in the unfiltered water.

Our experience with the use of ozidizing agents leads us to believe that ozone as a decolorizing agent offers practically no hope for successful results at a reasonable cost.

While we are keenly interested in the development of the ozone process we have no hesitancy in stating to you in unqualified terms that it has not reached a state of development where a city of the size of Montreal can afford to figure on its installation under present conditions.

Paris, October 7th, 1913.

Mayor Ellis,
City Hall,
Ottawa.

We believe for about two hundred and sixty six thousand dollars per year we could build filtration beds latest model and ozone installation complete. Operate same ourselves delivering you daily twenty five million gallons of pure crystalline sterilized water during thirty years, after which complete installation becomes gratuitously property of City Ottawa according to my letter nineteenth September. If in principle this price suits you send us your engineer with all details or we will send you our engineer to Ottawa.

Kindly cable reply.

(Sgd.) BEHRENS, ENOZO.